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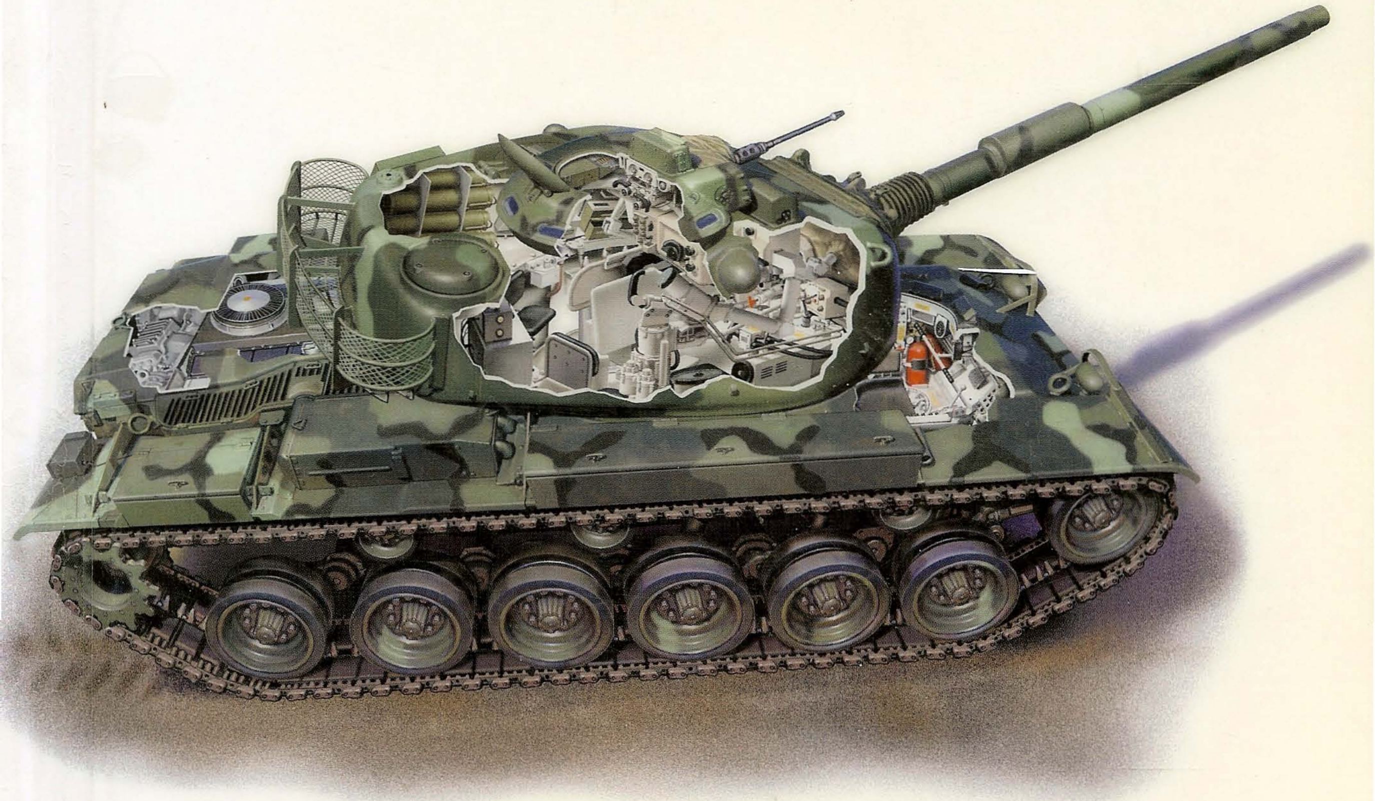
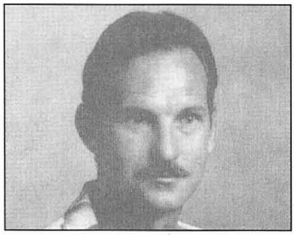
M60 Main Battle Tank 1960–91

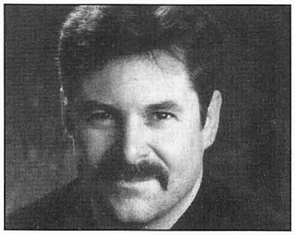


Lathrop & J McDonald • Illustrated by Jim Laurier

RICHARD LATHROP was born in 1967 and received his BA in History from Glassboro State College. He has always had an interest in military subjects and enjoys collecting and restoring military vehicles. He is married and lives in New Jersey.



JOHN McDONALD has worked for more than 24 years in the production and maintenance of combat vehicles and their weapon systems. His experience includes 13 years as a Worldwide Armored Vehicle Consultant and Overseas Co-production Manager. He has also conducted numerous operator, tactical and maintenance training classes for the US military.



JIM LAURIER is a native of New Hampshire. He graduated with honors from the Paiers School of Art, Connecticut, in 1978 and has worked as a freelance illustrator ever since, completing assignments on a wide variety military subjects, both aviation and armor, and is a Fellow member of the American Society of Aviation Artists, the New York Society of Illustrators and the American Fighter Aces Association.

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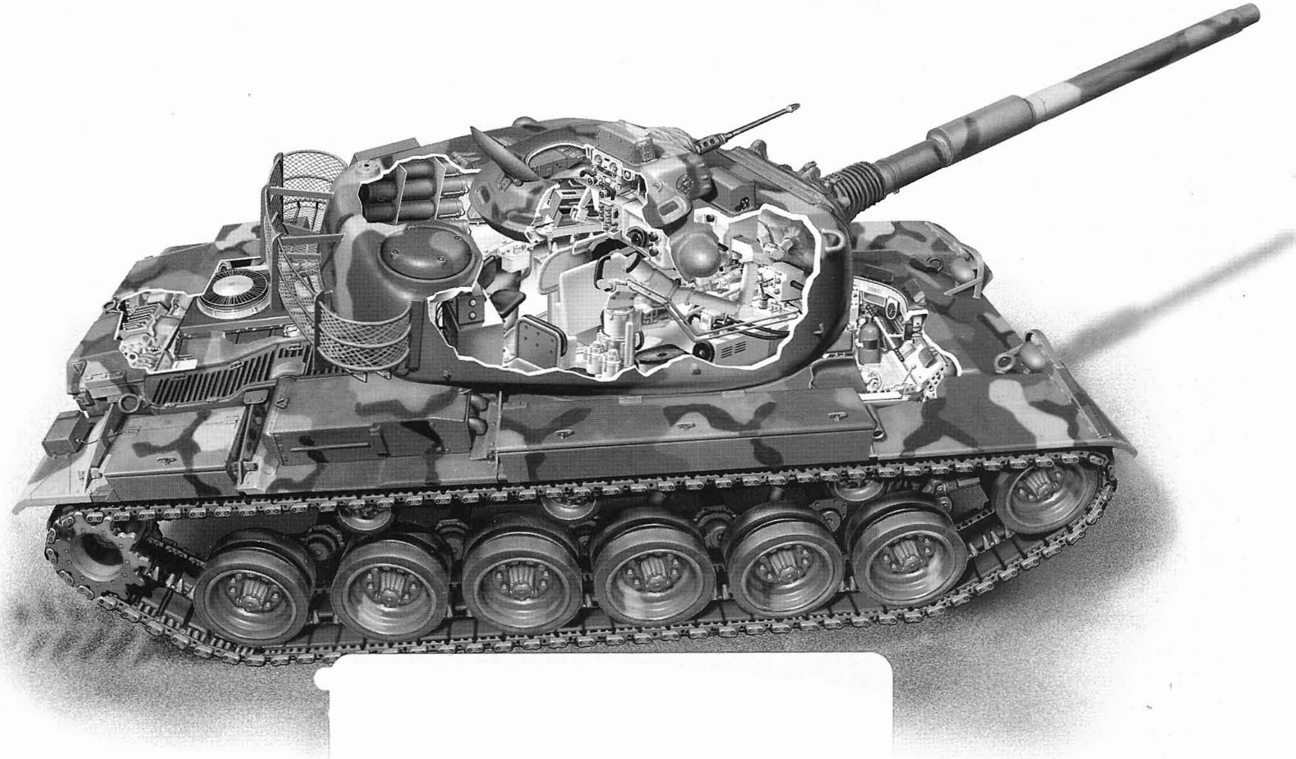

R Lathrop & J McDonald • Illustrated by Jim Laurier

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Jim Laurier, 85 Carroll Street, Keene, New Hampshire, NH 03431, USA

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THE M60 MAIN BATTLE TANK 1960–91

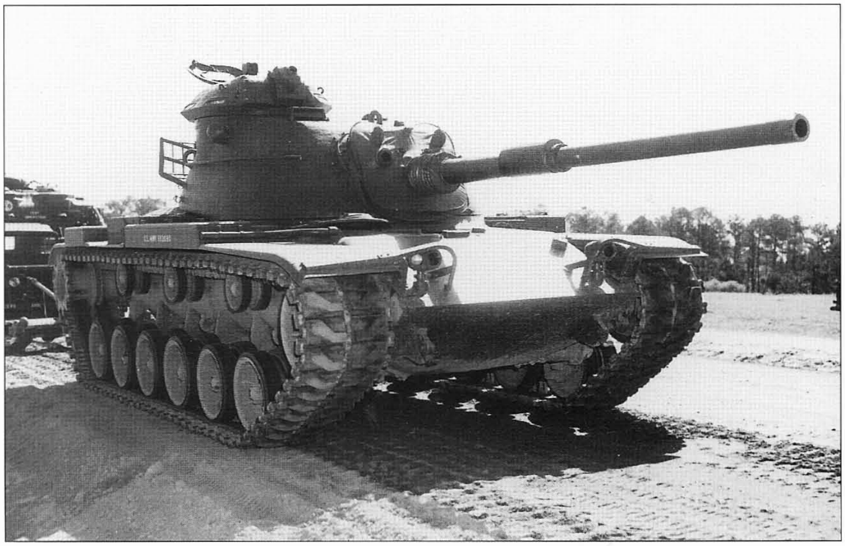
GENERAL BACKGROUND AND DEVELOPMENT

The development of the M60 tank began in 1956 when the US Army sought to improve the design of the M48 tank and standardize the equipment issued to armored units. Up until this point the tank battalions of the early 1950s had been equipped with a wide array of different tanks, including the M4, M24, M41, M47, M48 and M103. These tanks were arranged in light, medium and heavy tank battalions or regiments. The M4, M24 and M41 were designated as "light tanks" because of their 76mm gun. The M47 and M48 were designated as "medium tanks" due to their 90mm guns, and the "heavy tank" was the M103 with its 120mm gun. This wide variety of armor caused a logistical nightmare when it came to replacement parts and repair. It was also difficult to guarantee that the right type of tank unit would be deployed in battle, rather than what happened in World War II where M4 Shermans were pitted against the larger and more powerful German PzKpfw VI Tiger or PzKpfw V Panther tanks.

Army strategists knew that a 76mm gunned tank had no real stopping power and was of little use against most Soviet-produced tanks. The

President Dwight Eisenhower viewing a demonstration of the prototype M60 in 1960. The M60 served in the military during the administration of nine US presidents. (NARA)

planners were especially concerned about the new Soviet T-54, which British Intelligence had discovered had a 100mm main gun and 200mm armor protection on the turret. These concerns, coupled with the fact that they still used gasoline engines, only added to the inadequacy of the light tanks. The medium and heavy tanks were the closest to fitting the bill, but still not close enough. The 90mm gun of the M47 and M48 had barely enough power to penetrate the older Soviet armor, whilst the T-54 was another question altogether. The other major shortcoming of the M47 and M48 was they were also powered by gasoline engines. The M103 with its 120mm gun was strong enough to punch holes in any opposing Soviet tank, but it suffered from being underpowered and too heavy for most possible areas of operation.



Early production M60 shown on maneuvers. (NARA)

Due to the immediate concerns of the military strategists about the Soviet T-54 tank, it was decided to use the M48 as the basis for all upgraded vehicles to meet the new threat. The M48 was still very new to the US Army's inventory and was the most advanced tank in the US arsenal. Modifying an existing model would save valuable time in testing and development over building an entirely new tank design. It would also simplify the logistical support for the upgraded tank, since a considerable number of parts for the M48 were already part of the established logistical supply chain. For these and other reasons, the M48 proved the perfect candidate for this next phase of US tank evolution.

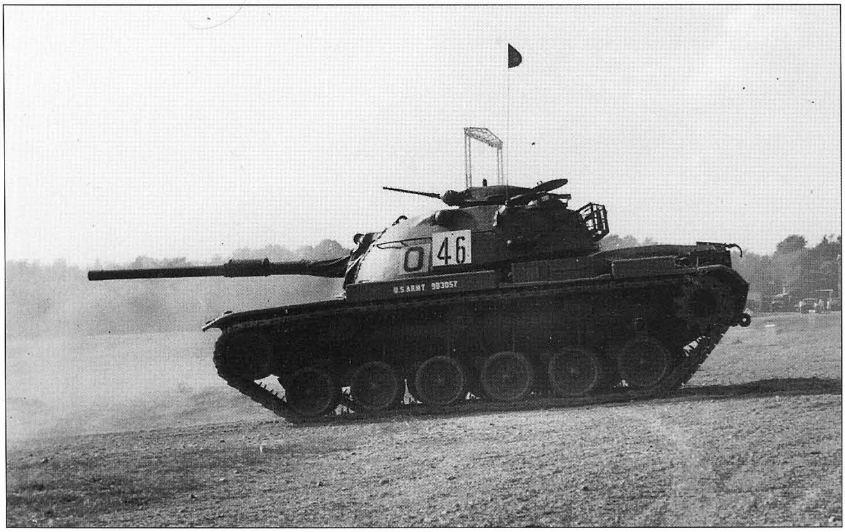
With the United States' key membership of NATO, the North Atlantic Treaty Organization, US Army and NATO planners sought to standardize as much equipment as possible. This meant attempting to create a number of interchangeable items and standardizing equipment across the alliance, everything from ammunition to tactical and non-tactical vehicles. This was designed to simplify the logistic supply system and reduce the number of different kinds of material needed to support any combined force that NATO might field in the future. Many of the NATO allies at this time, and well into the 1960s, were using obsolete equipment dating from World War II and spare parts for this equipment were becoming rare, but the greatest concern was that they were no match for their Soviet adversaries. In the late 1950s discussions about the joint development of a new tank with Germany were started. Germany's track record in tank design was impressive and their World War II designs had been the subject of much study by both US and British designers. A co-development program with Germany also had a political side to it; it would bolster West German industry and help develop economic ties with the US. The upgraded M48 was seen as an interim solution while the joint tank project, later dubbed the MBT70, was developed. The 1960s was a period of increased tensions between the Soviet Union and the United States, with each side believing that armed conflict was a very real possibility. Europe was to be the battleground again, but this time it would be former allies facing off. Memories of the Nazi armored columns plowing through the European countryside just over a decade before were still fresh and this vision of horror was very much at the root of NATO military strategy.

One of the first upgrades was the fitting of a larger gun to the M48 to enable it to defeat the new Soviet threat. Testing had shown that Great Britain's Royal Ordnance-designed L7 105mm gun was able to penetrate the armor of the T-54, as well as that of any other contemprary tank. The L7 was accepted into US service and designated the M68 after some minor modifications to shorten the distance of travel during its recoil. By accepting the new gun into service, it was hoped that all the NATO allies would standardize on the 105mm caliber, one of the much sought after goals of the alliance. The German smoothbore 120mm gun was also reviewed with great interest, but the L7 105mm gun won out because the German design would not be ready for production in time. However, testing continued for years to come on this larger-caliber main gun and it was finally used nearly 30 years later in the M1 Abrams tank.

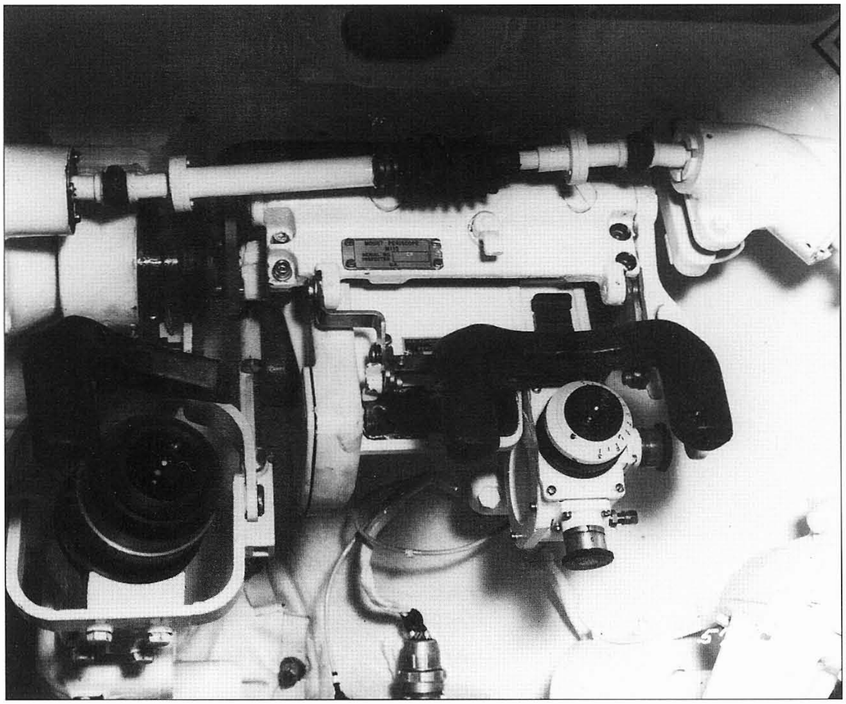
The M48's basic turret provided the required space to mount the new 105mm gun without making it bigger, which was one of the problems of the M103. A larger turret body meant a larger target and a higher silhouette to be seen by the enemy, and designers strove for a low profile throughout the M60 program. The hydraulic components of the M48 had to be modified slightly to handle the increased recoil of the new L7 105mm gun; it remained essentially the same as that used for the 90mm gun. The revamping of the turret body and hydraulic system allowed for high elevation and depression angles, as much as +20 degrees elevation and –10 depression. Another improvement the L7 gun had over the old 90mm gun was that it had a "bore evacuator" mounted on the barrel. The bore evacuator trapped the gases within the gun barrel when it was fired, thus preventing them from being sucked back into the turret when the shell casing was ejected after firing. The old 90mm gun didn't have this and the crew had to rely on a large exhaust fan mounted in the rear of the turret to evacuate the smoke and gases.

With the introduction of the L7, the sighting and fire control systems were also improved, with the key component being the M13A1D ballistic computer. This was not a

Early M60 being demonstrated on the firing range at Aberdeen Proving Grounds, Maryland. Aberdeen Proving Grounds are used by for the US Ordnance Corps and for automotive testing. Its proximity to Washington DC allows senior military officials to review new equipment. (NARA)



computer in today's sense of the word, but an electro-mechanical gearbox. The M13A1D had two inputs: the ammunition selector and the range, which was provided by the stereoscopic range finder. The ballistic computer's main component was a 12in. square box mounted just opposite the gunner's right elbow. To operate the M13A1D computer, the gunner would first select which type of ammunition was to be fired, such as High Explosive Plastic (HEP), High Explosive Anti-Tank (HEAT) or Anti-Personnel (APDS) ammunition, and rotate a selector handle until the name of that specific ammunition type appeared in the selector window on the computer. Next the tank commander would calculate the range to the target by using the M17 rangefinder, which had two periscope heads, one on either side of the turret. The primary periscope or lens was fixed while the other was adjustable and provided a ghost image. When the commander rotated the ranging knob it brought the two images together overlapping them into one image indicating the range to target. This figure appeared on the rangefinder indicator and was automatically fed into the ballistic computer; this was done by a universal jointed shaft running from rangefinder down to the series of gears and cams inside the computer. The computer then converted this input to the required elevation via the M10 ballistic drive and then to the M68 gun, thus elevating the gun to the proper angle for the target. This was a far cry from the days of guessing the range to target.



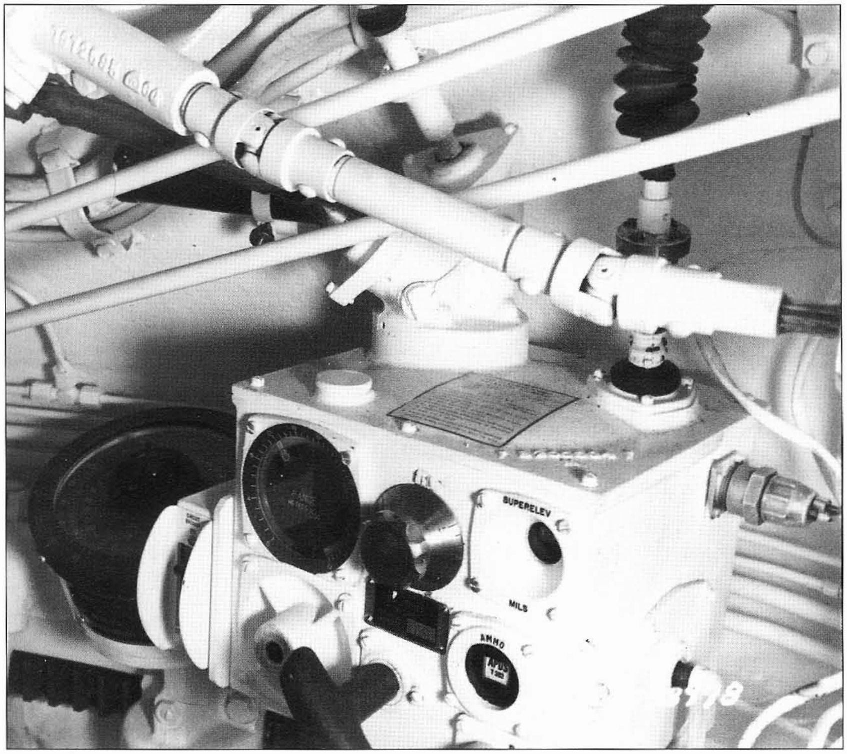
This photograph shows the gunner's periscope and main sight in an early M60. The main sight is to the left. In use the gunner would lay the gun in the general direction of the target using the periscope and then adjust it using the main sight. The periscope afforded a wider field of view. (NARA)

The next major improvement was to change to electrically fired ammunition, which meant the crew members no longer had to maintain mechanical firing pins and adjusting firing linkages, as was the case with the M48's 90mm main gun. Replacing the mechanical firing pin was an electrical firing pin consisting of a center pin fitted in the same place and insulated from the rest of the breechblock by nonconductive plastic. Electrical current passed through the center pin and on to the ammunition, thus firing the round. In the event that the turret's electrical power was lost, a backup power source was provided by a twist-crank blasting machine commonly used by army combat engineers or demolition teams. The crew could also harmlessly test the firing circuit at any time by use of a simple circuit test board. This was a piece of wood shaped to fit between the breechblock and the rear of the gun barrel. It had a contact strip of copper that linked the firing pin in the breechblock to a test lamp on the top of the board. The circuit was completed by the test lamp bracket making contact with the recoil mechanism surrounding the gun barrel. To test the firing circuit the gunner slid the test board between the breechblock and the gun barrel, powered up the turret and pulled the trigger of the control handles. If the firing circuit was in good order the lamp would light up. If the lamp did not light up the crew would have to troubleshoot the problem and correct it. Usually the problem was extremely simple and the crew could correct it without delay.

The hydraulic system for the M60 was designed and manufactured by Cadillac Gage of Warren, Michigan, and was an improved version of the M48's system as mentioned above. The operating pressure of the system was 1,200 P.S.I. (plus or minus 50 P.S.I.); this was achieved by the use of an hydraulic accumulator, which was divided into two chambers, one for the OH-10 (Oil, Hydraulic 10 weight) and the other one filled with dry nitrogen. The nitrogen provided the equalizing pressure so the hydraulic pump did not have to operate constantly when the turret was being operated and provided a near constant press to the components without causing any jerky or lagging motions to the system. This was extremely important when tracking a moving target with the main gun. The Cadillac Gage twin gunner's control handles located on top of the accumulator at the gunner's station resembled an "H" with the two uprights being the actual handles. Each handle had two switches; the first switch located on top for the index finger was the trigger to fire either the M68 main gun or the M73 (later the M219) coaxial machine gun. The other switch, located below the trigger switch, activated the hydraulic system so the turret traversed and the gun elevated. These handles became known as the "Cadillacs" by the crew because of the Cadillac Gage "bullet hitting the target" logo so prominently displayed on them.

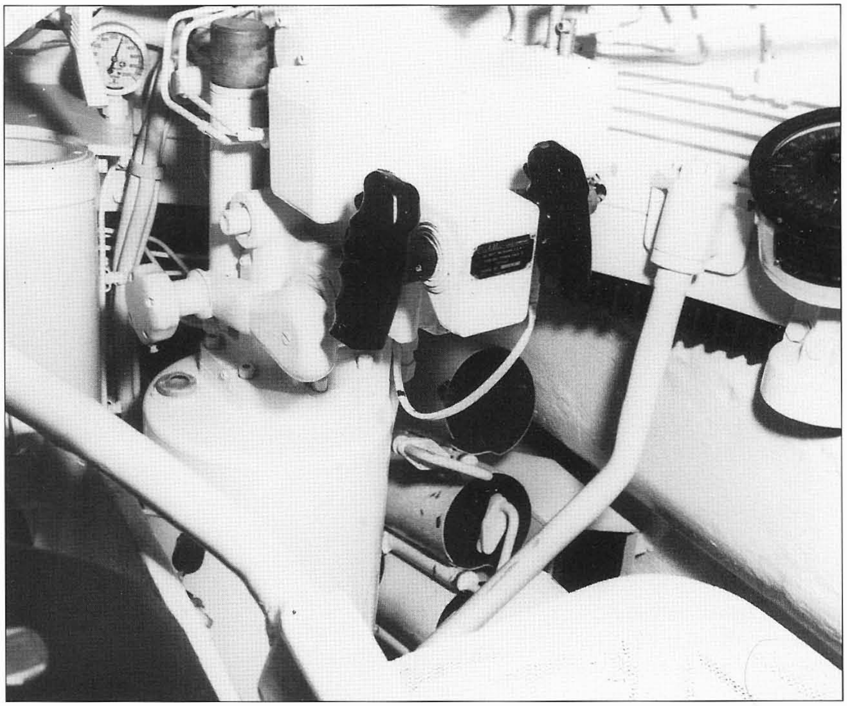
The tank commander had his own control handle that resembled a joystick. This was mounted on the top of the turret traverse gearbox and connected, via control linkage rods, to a hydraulic accumulator and electrically to the turret firing circuits. The joystick also had two switches like that of the gunner's control handles. The top one was for firing either the main gun or the coaxial machine gun, and the second switch was an override switch that

Top view of the ballistic computer showing the linkages from the stereoscopic rangefinder. The shaft shown above the computer is the manual turret traverse linkage. The interior of the M60 was painted a gloss white to reflect light while the tank was operating buttoned up. (NARA)



allowed the commander to override the gunner's actions and lay the main gun on a new target or even fire the guns if necessary.

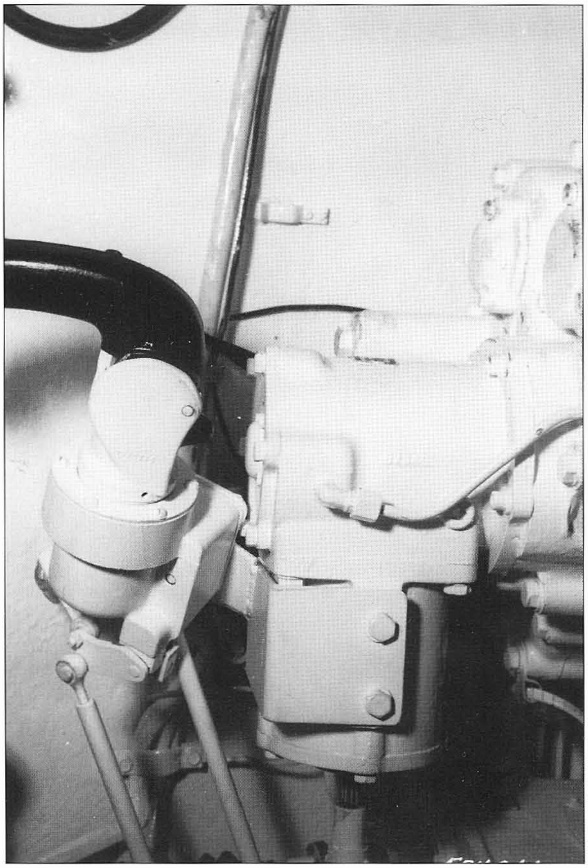
Another major improvement to the M48 turret was the fitting of the M19 tank commander's cupola; this was larger than the cupola on the original M48 turret and provided better visibility when the hatches were closed. The M19 mounted an M85 .50-caliber machine gun for anti-aircraft defense and use against lightly armored or soft-skin vehicle targets. The M85 could be configured to feed ammunition from either right or left hand sides just like the standard M2 .50-caliber machine gun. The M85 had a shorter barrel than that of M2 and could be field-stripped faster. Overall the new cupola design provided much better ballistic protection against small arms fire than previous versions, as well as more room inside.



The gunner controls, nicknamed "Cadillacs," for traversing and elevating the main gun. Switches located on the grips fired the main gun and the coaxial machine gun. Note the round storage to the right of the controls. (NARA)

Three M48s were modified with the new M68 guns and sent to be tested at the proving grounds at Yuma Test Station, Fort Churchill, Fort Knox and the climactic testing hangar at Elgin Air Base. The modified M48's chassis design was adequate to support the additional weight of the new gun, but it was decided to upgrade the tanks with a new diesel engine instead of the V-12 air-cooled gasoline model that was currently installed. The army had decided to use diesel fuel instead of gasoline, which was more commonly known as "MO Gas," due to the flammability of the enclosed gasoline engines. The diesel engine selected was the Continental Motors model AVDS 1790-2, which was a 90-degree air-cooled V-12 configuration. Coupled to the new power plant was a new General Motors (Allison Division) CD-850-6 transmission, which was designed to handle the increased torque output of the diesel engine. This was the cross-drive automatic transmission with two forward speeds, a high and low range, and one reverse speed which coupled between the engine and the final-drives of the tank. The final-drives transmitted power to the rear-mounted drive sprockets and onto the track itself. With the new engine, transmission and turret changes these modified M48s were given the new designation of XM60, the "X" stood for experimental. The new tank's power to weight ratio was somewhat lower than expected and its ground pressure higher than hoped for, but the ratios proved workable. Testing revealed that it met most of the project's requirements, but there were still more improvements needed. And as technology advanced in the fields of hydraulics, electronics and composite materials, the M60 was continually upgraded.

By 1959 the basic testing and evaluation of the XM60 had been completed and the vehicle was accepted by the US Army and quickly ordered into production. Despite the fact that the new tank was an improved version of the M48 tank and shared many M48 components the new tanks were designated as the M60 instead of the M48A5. The M48A5 did exist, but was really a hybrid of the M48 and M60 intended for foreign markets. But by this time the M60 had become the standard and further M48 modifications were not carried out by active US military units.

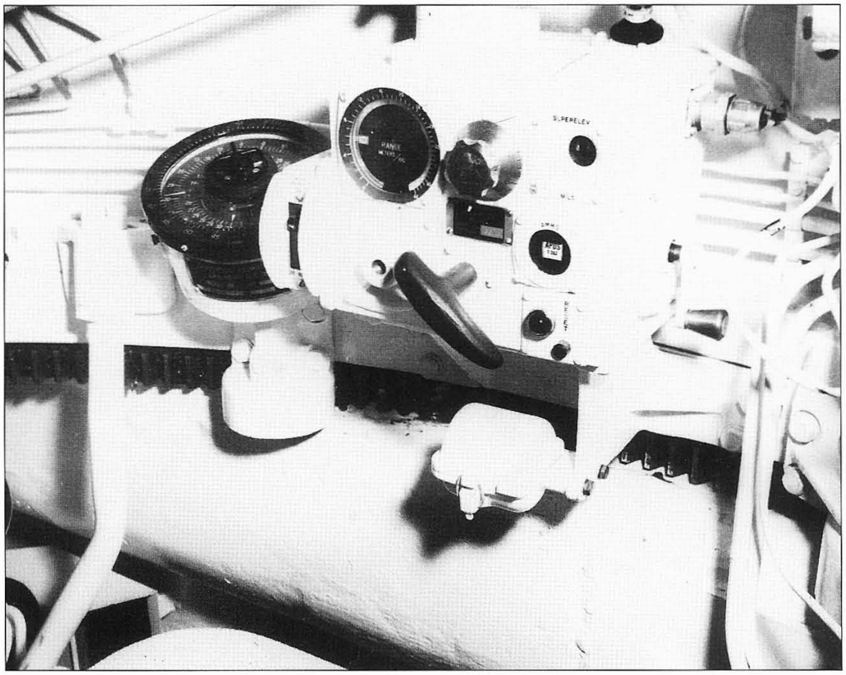


Interior view of an M60 turret showing the traverse motor and the commander's turret control. The traverse motor was located on the right side of the turret to the side of the gunner and in front of the commander. The linkage at the top allowed for manual traverse if the hydraulic motor were damaged. (NARA)

Ballistic protection and design changed slightly in order to add additional armor protection, and to simplify the construction the nose of the hull was changed from a rounded bulb shape to a straight wedge shape. The new wedge shape front glacial plate was also designed to deflect other tank or anti-tank rounds when fired at the front of the M60. The hull consisted of four castings that were machined and welded together. The completed hulls and components were X-rayed for defects to ensure the hull's ballistic integrity. However, in the 1980s there was a controversy over the reuse of X-rays of hulls by defense contractors who were building M-60 tanks for the Egyptian military as part of a co-production program. These X-rays had been doctored to show different hull numbers when in fact they were the same hull used over and over again. Some of these tank hulls developed serious cracking problems and it was then the doctored X-rays were discovered after lengthy research into the cause of the problem. The new M60 hulls incorporated two fuel tanks that were built into the hull and held 375 US gallons (1,420 liters) of fuel. This gave the tank a range of 280–310 miles depending on the condition of the terrain and speed at which it traveled. Tanks are not known for their fuel economy.

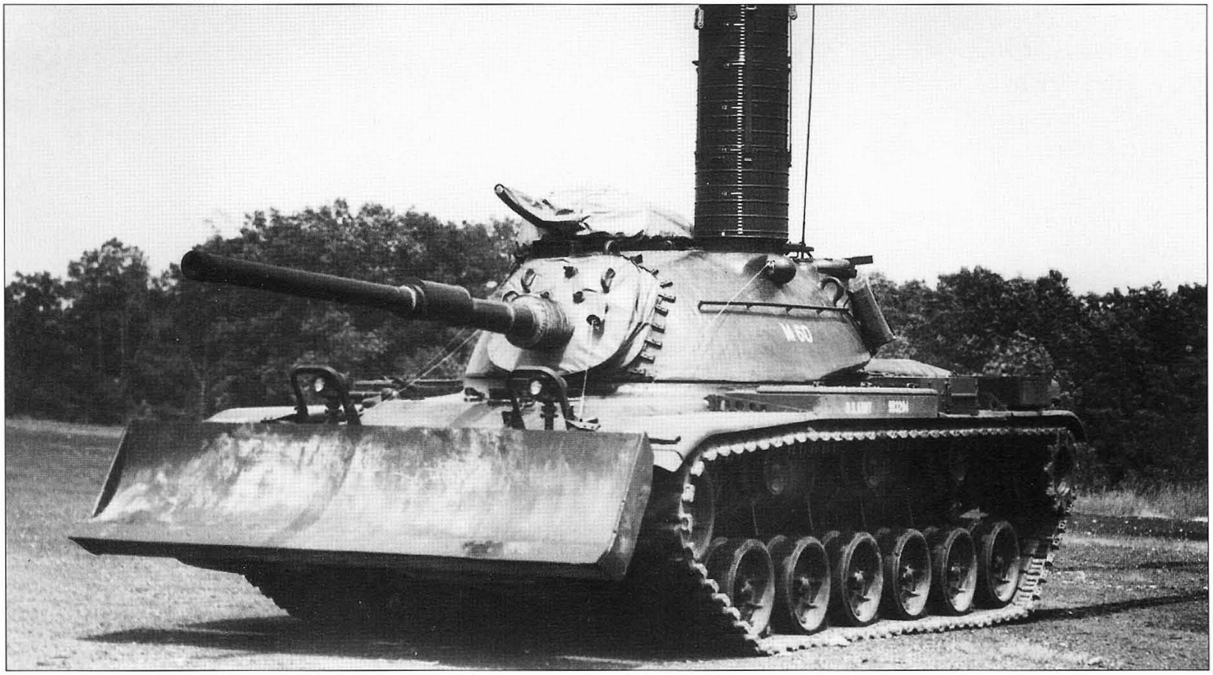
The torsion bars of the suspension were increased in diameter to handle the increased load and provide stability for the tank when traveling cross-country. In order to reduce overall weight the road wheels were changed from steel to aluminum alloy. Early troop and evaluation testing at Fort Knox, Kentucky, revealed that the suspension changes were not able to sufficiently absorb the shocks of traveling over rough terrain; shock absorbers were then added to the number 1 and number 6 road wheel locations. This suspension change also improved the ability of the gunner to track targets while on the move. It also reduced the overall fatigue of the crew after long periods of tank operation.

The driver's position was located at the forward center of the hull with his hatch just forward of the turret ring-gear. The driver used a wheel for steering the M60, but this was changed to a T-shaped bar configuration in M60A1 models. The driver had two large pedals located on the floor forward center of his seat for braking and acceleration. The brake pedal was large enough to accommodate both of the driver's feet for quick stops, which would require all of his strength. Early M60s used mechanical brakes, but these were later replaced and retrofitted with a more up-to-date hydraulic braking system that became standard on the M60A1. Located to the right of the driver was the transmission shift selector for selecting the gears. Also located in the driver's compartment were large instrument panels positioned on either side, providing information such as oil pressure, alternator state, fuel level and speed. However, when driving the M60 the driver usually was too busy to watch the gauges and they needed to be checked when the tank was stationary. As was common on many military vehicles the gauges had a tendency to stick.


Early M60 ballistic computer. The gunner would input ammunition type using the crank on the right side of the computer, range was fed into the computer by the stereoscopic rangefinder. The computer would then calculate the elevation required to hit the target. The round item to the left of the computer is the turret position indicator. (NARA)

As part of the ongoing development of the M60, various kits and modifications were developed to enable the basic M60 tank to be modified to meet the many tasks it was needed for. Some of the modifications developed beyond the prototype stage included the rake, plow and deep water fording kits. The rake and plow were primarily developed for roadway clearance and the removal of land mines, obstacles, barbed wire, rubble and earth works. The aim was to have a system that could be attached and detached as needed without affecting the primary performance and purpose of the M60. The drawback to most of these modifications was that they added weight and stress to the tank's chassis. The deep water fording kit was a little more complicated, though a must for US Marines due to the amphibious nature of their operations. Their tanks were modified with intake and exhaust snorkels, and inflatable rings around the hatches and turret gear ring. When not in use the Marines would store the snorkels and attachments across the back deck or the engine cover of the M60. Maintenance of the inflatable rings was an ongoing process to ensure their serviceability. One problem encountered was the crew, particularly the driver, forgetting to deflate the turret ring collar. When the turret was rotated it would tear the collar making it unserviceable. Unfortunately this would not be discovered until the next time the crew were called upon to take their tank in deep water when the water would come pouring through the ring gear.

Another part of the deep water fording kit was an extended commander hatch tube that resembled several 55-gallon barrels welded



Test M60 fitted for deep water fording. The tube enabled the tank to operate fully submerged. The tube was rarely, if ever, used with bridging equipment preferred for crossing large water obstacles. A bulldozer blade is also being fitted. (NARA)

together and attached to the commander's hatch opening. The intent was to provide the needed air to both the crew and engine for really deep water fording, but this configuration never really caught on and proved ungainly to install and store when not in use.

PRODUCTION AND TESTING

Accepted into service in 1959, production started at the Chrysler Tank Division Plant in Newark, Delaware, where 180 units were built. In 1960, production of the new M60 shifted to the tank arsenal in Warren, Michigan, where it remained until 1987. An additional production plant was located in Lima, Ohio, when production rates were ramped up. These tanks were delivered with the exteriors painted semi-gloss Olive Drab while the interiors were semi-gloss White. The white stars and unit markings were added after the tanks were received by their units.

Testing continued throughout the production life of the M60 at such facilities as Fort Knox and the huge climate control lab at Elgin Air Force Base. One such test was conducted in 1960 by three US Army scientists: Calvin Moier, Dr Arthur Woodward and Frank McIntyre, to provide data on crew fatigue versus combat readiness. The test was conducted with the three scientists "buttoned up" inside an M60 for 24 hours to simulate conditions that a crew might have to endure during actual combat conditions. These tests pointed out a few shortcomings, such as the gas mask filter air system needing to be heated so as not to freeze the face of the crew when in use during cold climate conditions.

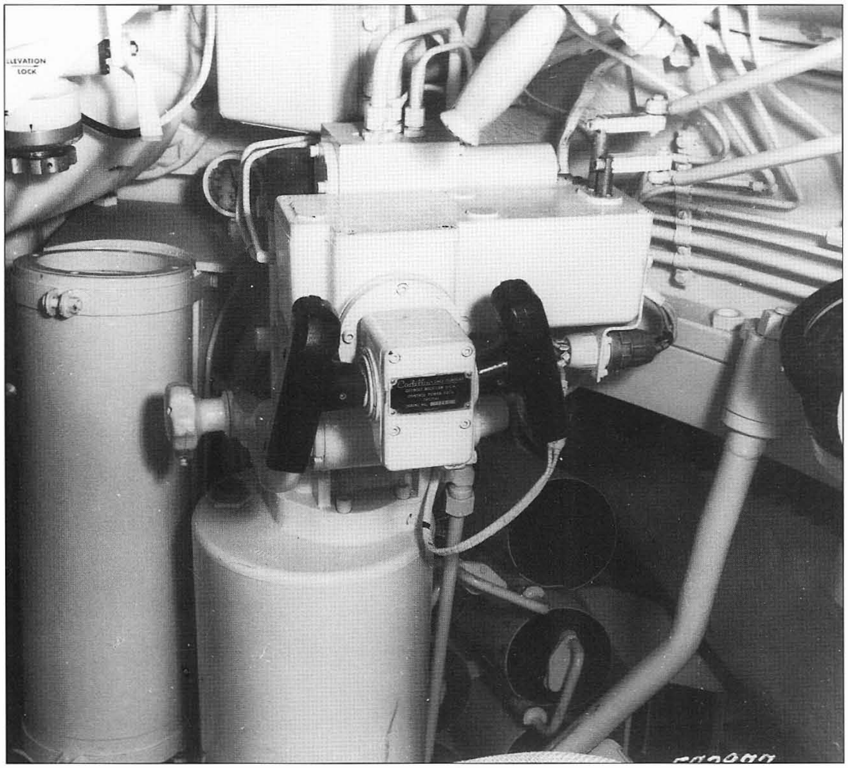
Deployment of the M60 began in late 1959 to US Army units in the US and was closely followed by deliveries to US forces in West Germany. Army planners perceived the Soviet threat to be at its greatest

Two M60s on maneuvers. Due to shortages of the M85, M2 machine guns were fitted to the exterior of the turret for a short time. (NARA)

in the European theater and wanted to deploy the new tank to counter any possible Soviet armored threat there. As the new M60 arrived the older M48s were replaced and eventually refurbished and reissued either to other regular US armored units or to National Guard units. The M60 never saw service in Vietnam for several reasons, mainly because the Army General Staff did not consider that the North Vietnamese forces posed a serious armor threat or capability that the M48 could not handle. Additionally the focus of the deployment was to US forces in Europe, the expected theater of operations where the M60 would most likely be needed to counter the perceived attack of massed Soviet armor formations. As units in Europe completed the transition to the new tanks, US forces in South Korea began to be upgraded with the M60 as well. As the M60s were received by the various armored commands they became the focus of much pride and were shown off at every chance. The National Archives have photos of at least four different US presidents reviewing the parading M60s "passing-in-review:" Presidents Eisenhower, Kennedy, Johnson and Nixon.

However, there were some minor difficulties in outfitting the M60 with all the proper equipment. The M85 .50-caliber machine gun was not available to many armored units in West Germany, and this resulted in a minor modification being done. The addition of a machine-gun mount welded on the outside of the M19 cupola allowed the installation of the standard M2 .50-caliber machine gun, of which there was ample supply left over from the M48. The fix was a temporary one at best as it did nothing to provide ballistic protection for the tank commander when he was firing. Eventually the shortages of M85s were filled and this modification was no longer required and subsequently removed.

By 1963 more improvements were made to the M60 based on the early production experiences and feedback from troops who manned them. This new version was initially called the M60E1 and was soon designated the M60A1. 2,205 M60s had been produced by the time of the introduction of the M60A1. The A1 version featured a larger turret with the 105mm main gun moved forward 5 inches from its position in the previous model. Additionally the new design added more 105mm

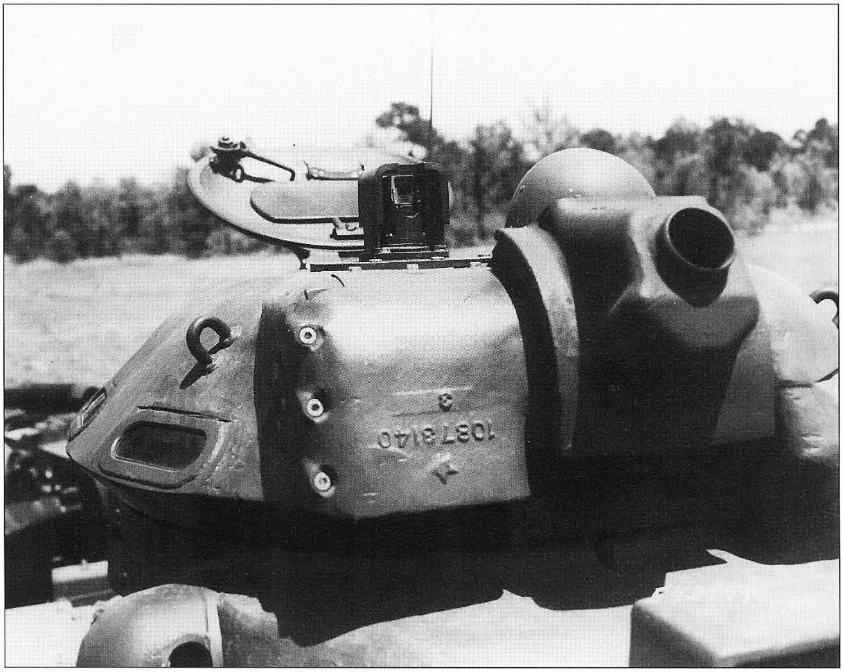


Top of the gunner's controls. The knob to the left of the controls is the manual elevation. the manual traverse handle is above the controls. These controls would only be used if the hydraulic system or motors were to fail during combat. (NARA)

ammunition storage inside the turret, more radio rack space in the rear and improved ballistic protection for the turret crew. The modifications didn't stop with the new turret; an upgraded engine, the AVDS-1790-2A, was added, giving the M60 an additional horsepower rating of 750hp at 2,400 rpm. This was to handle the additional weight from the new turret design and the additional ammunition storage.

Meanwhile Cadillac Gage, makers of the hydraulic system for the M48 and M60, had developed a new stabilization system for the main gun first for the M48 and then for the M60. After much field testing in the United States and overseas, a Maintenance Work Order, or MWO, was issued by the US Army's Tank Automotive Command, TACOM, to have the M60s and M48s in the US Army inventory upgraded with the new stabilization system, which incorporated gyros and servos to the turret hydraulic system on both the traverse and elevation portions of the system. The system enabled the gun to remain on target no matter which direction the tank was traveling in. This doesn't mean the gun stayed exactly on target but merely stayed pointing in the general direction and it was up to the gunner and tank commander to aim the gun back on target before firing. The stabilization system added a whole new dimension to the survivability of the tank and its crew, and increased the ability of the M60 to get the first hit on any opposing armor. Later production M60A1 tanks incorporated the stabilization system right from the factory. These were designated by having a "J" or "JJ" in the tank's registration number. Stabilization kits were marketed and sold to both US and foreign military. The latter provided an ongoing source of business that lasted well into the 1990s. Modifying entire M48 or M60 fleets to the latest standards often proved more cost effective than purchasing new fleets of tanks for many countries.

Another improvement incorporated in the M60A1 was the installation of the M32/M35 sights. These gave the gunner and commander night vision capabilities; the first version introduced had both a day sight and an infrared or IR night sight. The drawback with the infrared sight for both the gunner's and the driver's night sight was that it required an active infrared light source. For the driver's M24 IR sight this came from the two special IR filter lenses over the headlights. This



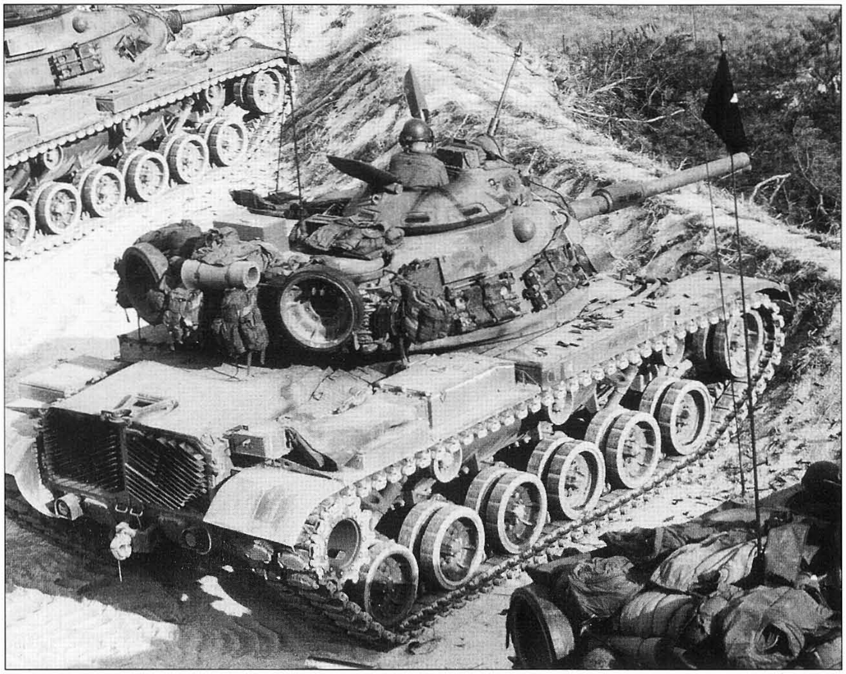
The M60 featured a new 360-degree turret for the commander and was fitted with an M85 machine gun. In use it was found to hamper visibility of the commander and the M1 tank did away with the cupola for the commander. (NARA)

was later replaced with the AN/VVS-2 sight. For the gunner's sight, the IR source came from a large Xenon searchlight mounted over the M68 gun barrel near the gun cradle. The problem with using IR sights was that anyone else with IR night sights could see you too.

A standard army tactic to counter this drawback was to use other infrared light sources to illuminate the target so that the M60 tank crew could then use its infrared sights to engage the target without giving away its position until firing. M151 jeeps, or MUTTS as they became known, were fitted with Xenon searchlights for this purpose. Several such vehicles would be positioned along a line to provide light onto a suspected target. Using several different IR light sources ensured good illumination and could also triangulate the target or targeted area. This later led to the development of the M36E1 passive night sight, a sight which didn't require an alternative light source but instead magnified existing light. The M36E1 was introduced and retrofitted to the M60 fleet. Additionally this same sight was adapted to the M19 commander's cupola to replace the existing M28 periscope, which had no night vision capability whatsoever. However, an alternative use for the big Xenon searchlight was discovered and exploited by tank crews. This was to use it as an open air oven to heat their C-rations. The crew would partly open the C-ration can or just punch holes in it and then place it on the gun tube or the bore evacuator. When the searchlight was turned on the food would be ready to eat within a few seconds. If the soldier forgot to punch a hole in the C-ration container it would explode throwing the contents all over the place.

By the end of production in 1981, 7,948 M60A1s had been produced, including 578 for the US Marines. This made the A1 variant the most produced of all the M60 models. It should be noted many of these M60A1s were in reality reconfigured or reworked M60 models.

As has been stated earlier, the US Army believed that Western Europe was to be the next most likely location for a confrontation with the Soviet Union. This posed the problem of how to get the tanks to the battlefield quick enough to face this threat. By the late 1960s enough M60s had been produced to begin "pre-positioning" or "PREPO" in Western Europe. These storehouses of material served two purposes, the first and foremost was to have armor and equipment in place in the event of any possible Soviet aggression against any of the NATO allies, and the second was for US-based soldiers to have tanks



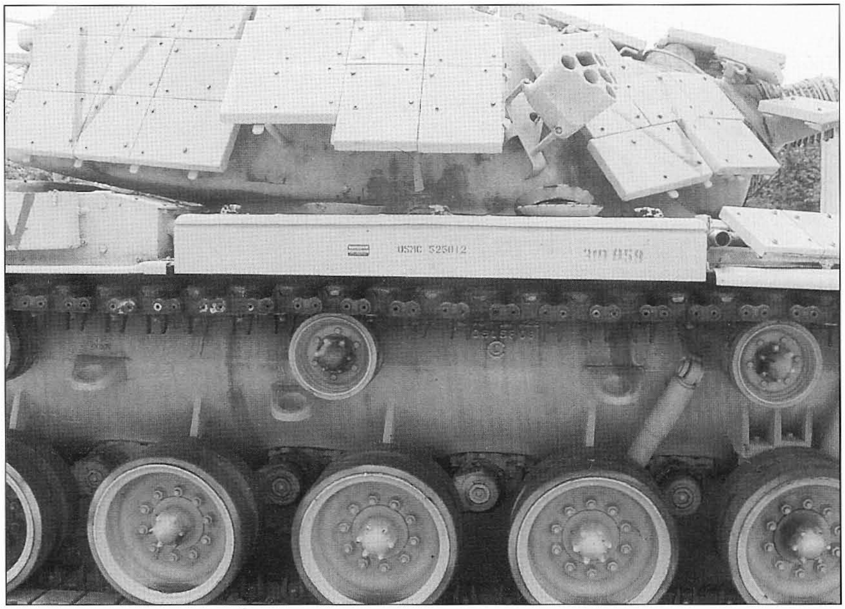
A rear view of M60A1s on a firing range in Korea. Crew ALICE packs are strapped to the rear turret rack as well as extra road wheels. Storage arrangement on the M60 varied with each unit. (DVIC)

and support equipment available for them when they arrived in Europe. The tanks and other support vehicles were stored in open-air tank parks and large warehouse complexes. The army developed several methods for long-term storage. One of the systems adopted was a large black heavy-gauge reinforced plastic bag in which the tank was be placed before it was vacuum-sealed and closed. This method protected the tanks for many months before they were removed from their cocoons for maintenance or inspection. As time went on and other threats loomed around the world new methods were put into effect. One of the most widely used today is a series of floating warehouse ships, or PREPO ships, positioned around the world. Civilian contractors man these ships, and their contents, including tanks, are maintained by both US military and civilian maintenance teams. The PREPO ships rotate between the designated PREPO ports: such places as Diego Garcia in the Indian Ocean, Hythe, England, and Kwajalein Atoll in the Pacific Ocean. These floating warehouses can arrive on the scene in a matter of days instead of the weeks that it would take if the equipment had to be shipped from bases in the United States or from Europe. It was from the PREPO port on the island of Diego Garcia that much of the equipment was used against Iraq in the 1991 Gulf War.

Reforger

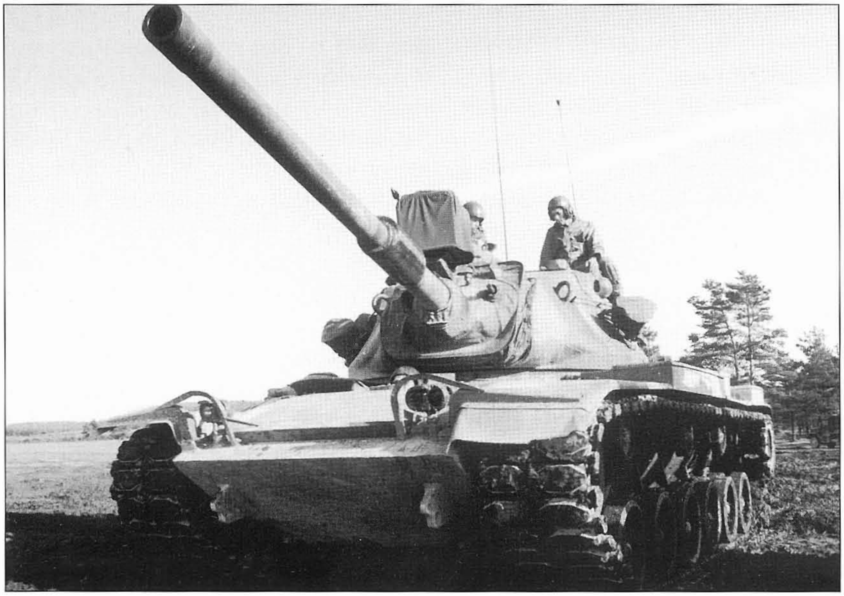
Every year US-based soldiers participated with other NATO allies in exercises known as Reforger. Reforger was short for "Return of Forces to Germany" and was designed to simulate a response to a Soviet invasion of Europe through East Germany. US soldiers normally based in the Continental United States arrived in Europe, were issued with equipment from the PREPO pools, and engaged in war games against other US and NATO allies.

The first task of the arriving Reforger soldiers was to begin prepping their tanks for use. The crews had to do the normal services and checks, but the most critical was exercising the gun tube. The preferred method was to rig a block and tackle over the end of the gun tube and then attach the two ends to the forward lifting eyes on the turret and ratchet the gun back to the recoil position. This was often too slow and the inventive tank crews opted for the faster method of slowly driving the tank with its gun barrel straight forward into a thick wall, tree, pole or other large object, thus slowly pushing the gun tube into the recoil position. This was done several times before the tank was ready to fire its 105mm gun. The reason this was done is simple, because the gun had sat idle for many months and there was a chance that the recoil seals may have hardened and turned brittle. The hydraulic seals around the gun tube and inside the recoil housing therefore needed to be tested and exercised to prevent them from bursting and showering the crew with hydraulic oil the first time the gun was fired.



Side view showing detail of the supplementary armor fitted to the M60A1. The additional armor required moving the external turret storage boxes. Note also the extension to the mount for the smoke grenade launcher. (Authors)

Other maintenance items the crews had to contend with were not as exotic but just as important. The six batteries located under the turret and accessible through a metal trapdoor in the turret basket floor had to be inspected. The turret had to be traversed to align the trapdoor directly over the batteries. Once there the batteries were inspected with ease. Besides the batteries' acid levels and the terminal clamps, it was important to ensure that the batteries' hold-down brackets were securely attached. If these hold-downs were loose or broken it was possible for the batteries to bounce up out of their trays and arc against the underside of the turret basket killing the tank's power or starting a fire under the turret floor.



Taken during Reforger exercises, this M60A1 of the 157th Armored Regiment is fitted with a Xenon searchlight for engaging targets at night. The presence of the smoke grenade launchers indicates that this is a later M60A1, as they were not fitted until the late 1970s. (DVIC)

Two M60A3s during Reforger exercises in 1985. The first tank is fitted with an amber beacon as part of the MILES system to indicate hits by opposing forces. The rear tank's beacon seems to be damaged. Note the large amount of equipment stored on the exterior of the vehicle. (DVIC)

Periscope and sight inspection was of equal importance. The crew had to inspect each periscope and sight to ensure they were clear to view through and that there was no moisture or clouding inside the unit. If there was moisture present the unit would have to be purged with dry nitrogen. This was not overly complicated but was done by higher-level echelon maintenance personnel because most armored line units did not have the proper equipment or expertise to perform the task.

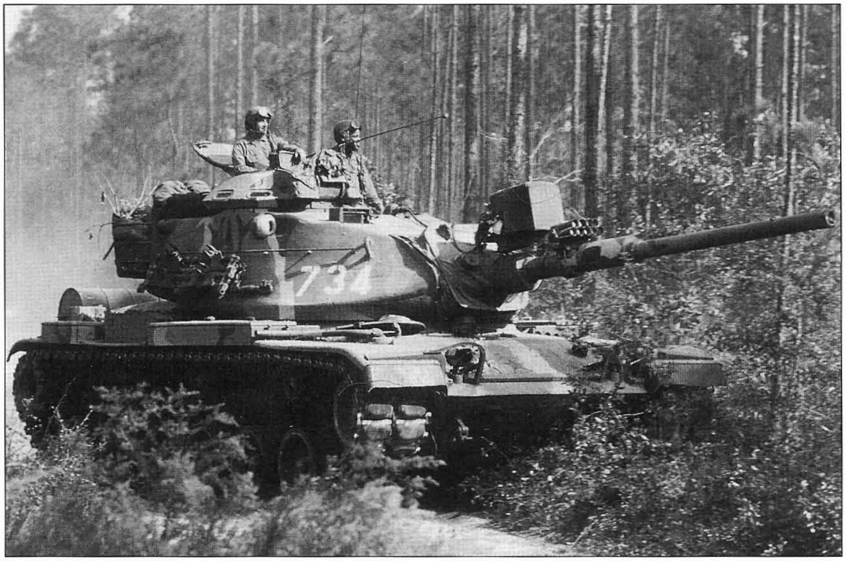
Purging of the M60's sights and periscopes was essential for several reasons; the first and most important was if you can't see the target you can't hit the target. The second reason was that if the sight's interior was subjected to long periods of moisture it could damage the internal components through rust on the prism's mounting arm or even undoing the glue which holds the prism in place. In severe cases fungus grew inside the sight and no amount of purging would clear that up; the sight had to be completely disassembled, cleaned and reassembled. Again, this was done by higher echelon maintenance facilities.

LIFE WITH THE M60

Training varied greatly between stateside armor units and those that were stationed in West Germany. Training exercises at stateside bases usually lasted a week to ten days for most tank units and afterward they could drive the tanks back to the motor pool and the crews could then head to their comfortable bunks and hot showers. Armored units stationed in West Germany spent weeks, not days, in the field and when one field exercise was completed it was off again to another one, not to mention border duty between West and East Germany. These training exercises included "live fire" exercises as well. These exercises did entail more work for the crew, but the satisfaction of blasting away with the M60's weapons somehow made all the extra work worth it. The major benefit of these exercises was the opportunity to evaluate the crew's performance and their gunnery skills. The standard tank gunnery courses undertaken by M60 crews kept them in practice, but these were carried out on a tank-by-tank basis. When field exercises were conducted entire companies, battalions and even brigades were involved in order to test the unit's overall readiness. Individual tank crews had to function as part of a tank platoon or company, all moving and operating as a unit.

The US tank crews in Germany became completely familiar with their M60s, starting with how to load their tanks onto railcars and secure them for journeys from one training area to another. Once there, they convoyed from the railhead to the training area. These training areas were vast and fully tested the crews and their tanks. Unlike the smaller cordoned-off areas of stateside training sites, the German facilities offered the exact combination of terrain the army planners thought the US crews would face if they were going up against Soviet Bloc forces. There were hills, streams, plains, forests and even destroyed villages with castles looming from hilltops. The two major training areas for troops serving or training in Europe were located in Germany at Grafenwoehr and Hohenfel. These two training areas were used by most of the NATO armies and often teamed different NATO member forces with or against each other to test and train them. Lessons learned there would change military doctrine and eventually lead to improvements to both the M60 and the future M1 tank.

Driving through the narrow German village streets was avoided if possible, but when it had to be done it was done with care. Often the German Police and US Military Police would monitor the convoys' movements. Many times the US European Command and German officials would cordon off certain parts of the training area, including villages, town and even forests to minimize damage. The damage caused by tracked armored vehicles and tanks to cobblestone roads, sidewalks, light poles, cars and even buildings was very expensive for the US military. Farmer's fields were also damaged when convoys of tanks took wrong turns in the middle of the night. The ruts left behind by a column of tanks were unmistakable and it was easy for the German civilian officials to track down the culprits to make good on the damages. Tracking a column of tanks was also easy for maintenance troops trying to catch them up: broken concrete, lost track end connectors, thrown track pads and soldiers' personal field equipment strewn about the roadway provided a clear trail. Armored maintenance crews and vehicles were usually

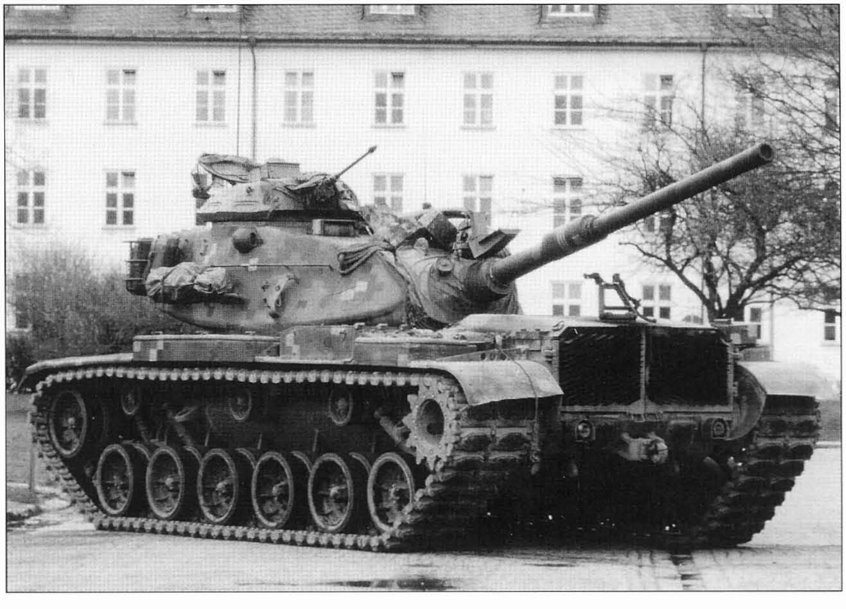


M60A1 belonging to the 24th Infantry Division is shown maneuvering during exercises in 1979. Note the crewmember equipment stored to the rear of the turret and extra track links on the side. The weight of a tank can quickly rise when loaded with additional gear and crew equipment for operating in the field. (DVIC)

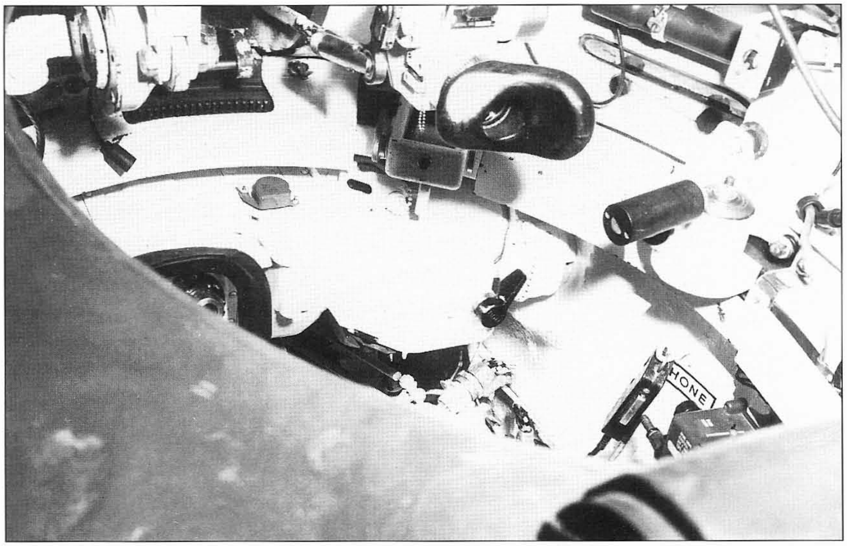
placed at the end of the convoy to pick up or repair downed vehicles and tanks along the way. In the event that a tank or vehicle could not be repaired on the spot it was towed to the next destination.

Either another M60 or the M88 recovery vehicle could tow an inoperative M60. The downed M60 would have its final drive couplers disconnected; that is the coupler between the transmission and the final drive gearboxes. Then the turret was turned so the gun barrel was stowed over the rear deck and locked in the travel lock located there. Once the turret was secured and the final drives disconnected the "V" tow bar was installed to the front towing shackle lugs after the towing shackles were removed. Once this was done the downed M60 with its mounted tow bar was coupled to the rear of the towing vehicle. The towing operation when underway was a bit tricky and had to be carefully monitored by the towing crew. The additional weight of towing another 60 tons meant that breaking distances were vastly increased so towing speeds were kept very low to prevent any panic stops. Making turns posed new problems and any sharp or tight turns were avoided at all times. Tow bars were not part of the M60's basic equipment or OVM, the tow bar was part of the M88's basic tools. M60 did have a tow cable as part of its OVM (Operator Vehicle Maintenance), but the tow cable was only designed for pulling or towing an M60 tank for a very short distance.

Training for the M60 crews consistently aimed for realism in all things, and operated under as close to real combat conditions as possible. Soon after the M60s began to be fielded by the US Army, development of a 105mm simulator was introduced. This simulator was a touch of Hollywood that provided the flash and bang of the 105mm gun without the destructive effects. It was a tube-shaped mechanism that attached to the top of the real 105mm gun and was fitted with gas hoses, a firing control box and gas canisters. The M60 could now sound like it was really firing, much like the blank adapters the infantry used on their M16 rifles. But even this was not enough to rate or grade field exercises and this eventually led to



This M60A1 is shown painted in an experimental paint scheme developed by NATO. The scheme, called DUO-TEX, consisted of small squares of color to create a camouflage patern. It was not adopted. (DVIC)

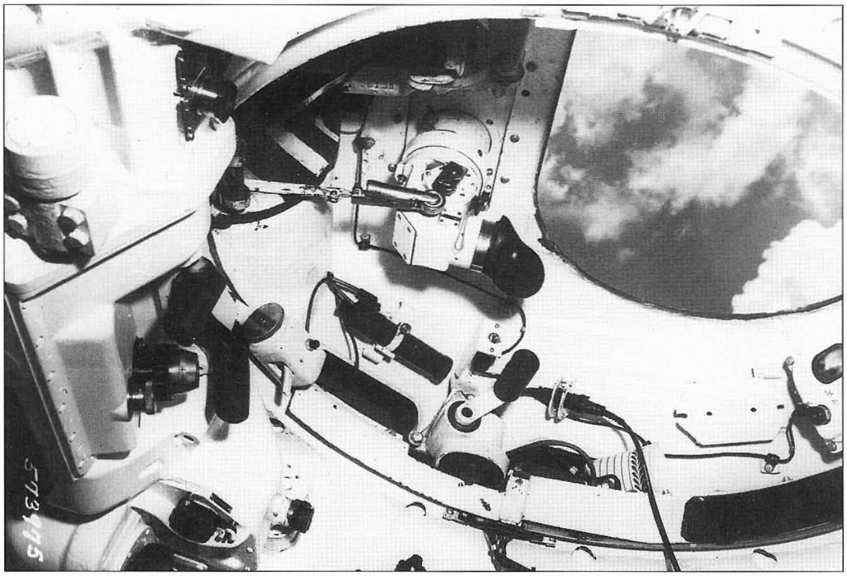


View looking down into commander's cupola from the commander's hatch showing the M36 sight for the M85 machine gun. (NARA)

development of the Multiple Integrated Laser Engagement System, or MILES. MILES was a string of laser sensors attached to an alarm. When the sensors were hit with a laser beam from another MILES systems the alarm was sounded, indicating that the tank had been hit by opposing fire. The system also activated with the sound of the firing of the simulator which the 105mm simulator was linked to and only worked as a line-of-sight mechanism. This meant no long-distance targets or targets that required elevating the gun to be hit, straight-line shots only. Though not as realistic as firing real weapons this allowed exercise graders to truly know who had fired the first shot and hit the target, improving the judging of the outcomes of the field exercises and providing quicker feedback to commanders. This was a great advance from the days of throwing sacks of flour at tanks to indicate hits.

Camouflage and concealment of the M60 tank was hammered home during training. Mud was smeared over the white stars and numbers, or they were taped over with green duct tape. Covering the shining headlights was also a priority. The tanks were parked in the tree-line or wooded area in order to disguise the M60's silhouette with tree branches and scrubs; that is, of course, if you were allowed to damage the forest and in most cases the German Forestry Service had strict rules against it. Any unauthorized damage to the greenery resulted in fines leveled against the US Army by the German Forestry Service. Camouflage nets had greatly improved since World War II when they were made of strips of burlap woven into a net. The modern camouflage nets were again net with fiberglass reinforced plastic leaf material that was reversible; one side for spring and summer and the other for autumn and the desert. This plastic material was attached to the net with aluminum clips that deflected radar signals and provided a second method of camouflage. The new nets also incorporated a system of collapsible poles with fan-like headpieces to hold the net away from the vehicle. When deployed in a controlled environment the new net was easy to erect but on exercise it proved to be a pain to set up and remove when speed was required. The nets were therefore often left draped over the tank at all times, and were tied down to keep them from being caught in the track or snagged as the turret rotated.

Driving in these training areas brought more problems. The trails were heavily traveled by tracked vehicles, which pulverized the earth into a very fine powder in the summertime. Great clouds of dust signaled the movement of vehicles and this same cloud of dust caused the tank crews to don goggles and fashion bandanas over their mouths and



View looking up at the commander's station in an early M60. Directly at center is the M36 sight. Commander's turret traverse is to the right, stereoscopic rangefinder is to the left of the sight. This was replaced in the later M60A3. (NARA)

noses. These same dusty conditions would be encountered nearly three decades later during the Gulf War in 1991. Driving in formation covered the crews from head to toe with dust; this same dust filled the tank and caused maintenance concerns for the M60's air cleaner, which had to be checked and cleaned as soon as possible after the exercise. These air cleaners were located above the track toward the rear of the tank where the dust was kicked up from the track.

M60 training during winter posed a new set of problems for the crew. The trails that were choked with dust in summer months now turned to rivers of mud, which was not just messy to drive in but dangerous as well. The M60's rubber track pads provided very little traction against the slippery mud once the track became clogged. The muddy trails could become so deep that tanks bottomed out leaving the tracks spinning with no traction as they became hopelessly stuck.

The soaked or thawing earth also made it difficult to traverse over hills where the tank could lose traction and slide out of control sideways down the hill. It was these conditions that caused the greatest concern because if the tank lost traction and began sliding sideways the M60's track could be thrown from its guides and there was nothing worse than having to replace a thrown track on the side of muddy hill, unless of course if a track was thrown in the middle of a muddy stream. Crews often attempted to increase the traction in snowy or icy conditions by removing all or some of the rubber track pads. This worked for a while until the spaces in the track where the pads had been became choked with ice and snow. This method did help somewhat with traction problems in winter conditions but played havoc with paved surfaces, for this reason it was not recommended as common practice. Images of M60 tanks with tracks spinning in reverse whilst they slid forward out of control on ice-covered streets were not uncommon during winter operations. All one could do was to get out of the way and wait for the icy dance of the 60-ton monsters to come to an end. For these reasons, winter operations were considered to be especially hazardous for tank crews and avoided whenever possible.

A common practice among tank crews was to wear their overboots when outside the tank and remove them before getting back into their positions inside the tank. The rubber boots were stored by being wedged in the step rails on the side of the turret. Why so much trouble over boots? It was not so much the boots, rather the mud that would be tracked inside the tanks. When entering the turret or the driver's hatch, you had to step on the seat where someone was going to have to sit. The

The tank commander's cupola on an M60A3. This vehicle is on display and the M85 machine gun, which would normally be fitted, has been replaced with a piece of pipe. The M85 machine gun was phased out of tank service with the advent of the M1 Abrams. (Authors)

second reason was that once the mud got inside there was no easy way to get it out again short of removing all the drain plates and driver's escape hatch and washing it out, which was an outdoors task in cold conditions.

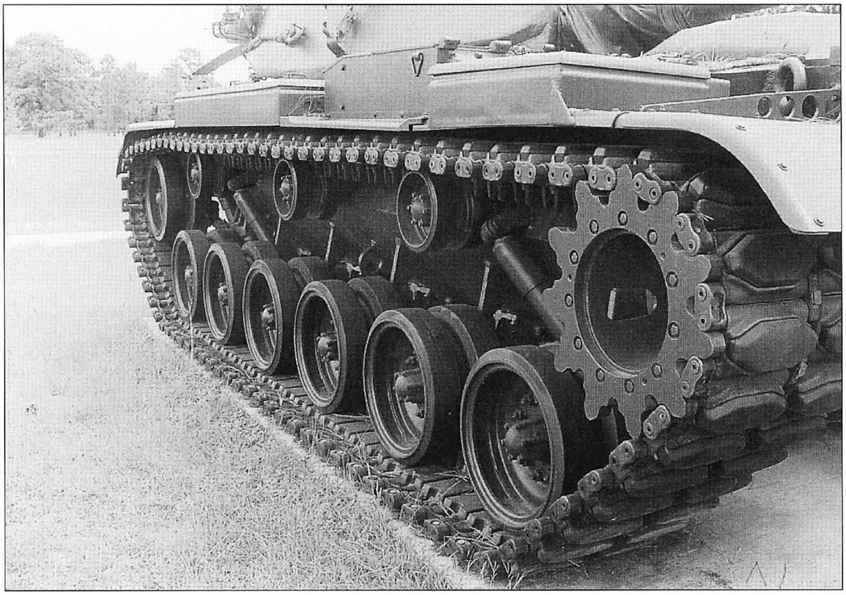
As the temperature dropped and the mud froze new problems were faced by the M60 tank crew. Keeping the inside clean was one thing, but removing mud from the track and road wheels before it froze solid was even more important. If the mud froze the tank would be stuck in its own tracks, so to prevent this from occurring crews drove through shallow streams or washed the tracks before parking them for the night. If they didn't they would have to use their pioneer tools like the Maddox or pry-bar (aka tanker's bar) to break the frozen mud and ice loose from the track so it could move again.

Ice storms brought a whole new set of problems. Not only was it dangerous to drive on icy roads or trails, but ice coating the surfaces of the tank made it extremely difficult to get on or off the tank without slipping. Ice also covered the optics making them totally useless for vision or sighting. Another concern was if the ice was thick enough the hatches froze shut making it very difficult to get out of the tank. There were heaters inside the M60 that produced 60,000 BTUs (British Thermal Unit) of heat. This kept the interior comfortable as well as dealing with the ice. However, the heater often didn't work. There were two major problems with them; the first, and biggest, was the fault of tank crews themselves. Before shutting down, the heater had to be purged. This was simple enough to do but the crew often simply killed the vehicle's master switch when exiting the vehicle without even turning off the heater. This caused the heater's igniter to become fouled with unburned fuel and then become unserviceable. The other problem was the exhaust pipe for the heater that ran outside the vehicle. In certain windy conditions the exhaust fumes could back up into the tank. To prevent possible carbon monoxide poisoning it was a common practice for crews to leave at least one hatch cracked open. Usually this was the driver's hatch because it was closest to the heater in the first place and could help regulate the fresh air and temperature balance inside the tank.

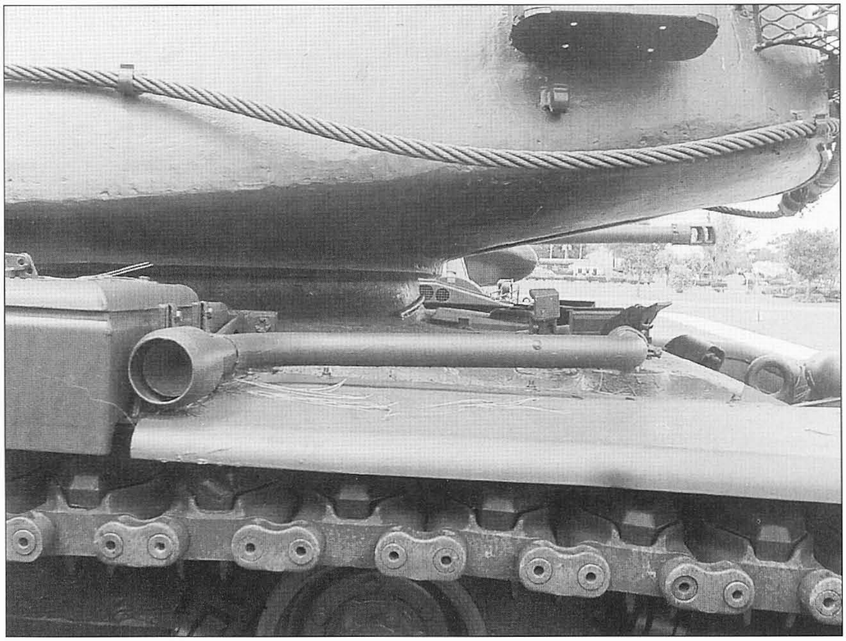
When in the field much of the crew's time was spent in or around their M60 and this included sleeping in it. The driver had the best position for this, with enough room to stretch out, even in a sleeping bag, as long as he did not stick his head into the turret basket floor area. The loader's position was the next best place. He too could use his sleeping bag and curl up on the turret floor. The gunner and commander were stuck with sitting in their seats and leaning forward on to their controls or resting their heads against the sight's rubber brow pads. This sleeping arrangement was usually done when it was raining or snowing. When the weather was more clement the crew fashioned a tent from the tank's tarp by draping it over the gun tube while the gun was in the stowed position over the back deck above the engine compartment.

During extremely cold conditions the tanks had to be started every couple of hours and run for several minutes. If the temperature was well below freezing the tanks were parked back to back or exhaust grill to exhaust grill and a tarp strapped over the two engine compartments to help hold the heat in. So while one tank was running it was heating the other. Ether was sometimes used to start cold tank engines, but it took a lot of ether and could damage the engines if it was overdone.

Maintenance was a major part of any tank crew's day-to-day activities; if they were not driving or firing the tank they were maintaining it. First and foremost was the track, it required attention after each mission or exercise. Each and every section of track had to be checked for serviceability and excessive wear; the track consisted of individual track shoes, rubber pads bolted on to cast metal track sections. If the blocks or shoes were worn or missing they were replaced. Additionally, every nut on the track needed to be checked to make sure that they were tight. Next, the end-connectors and the center-guides needed to be checked; these were critical because if they were loose or missing the tank could throw a track. The end-connectors were metal blocks in the shape of the letter "B;" they fitted over the track section pins and were held in place by a bolt and wedge nut. The center-guide, which also connected the track sections together in the middle, kept the track centered by riding between the road wheels, sprocket and return rollers. If the track was severely worn or damaged and needed changing this could be a serious job. Replacement track came in three forms: single-track sections, ten assembled sections or complete track rolls. The latter was usually used when the tank was back at the motor pool area and rarely carried to the field because of its extreme weight. To replace the track, the tank was parked on fairly level ground and new or repaired track aligned under the road wheels with the bulk of the track extending to the front. The tank was positioned three-quarters of the way along the laid-out track. The end of the track to the rear of the tank was picked up and threaded


Detail view of the later M60 showing the track and suspension components. The track incorporated replaceable rubber pads to minimize damage to roads. The road wheels were originally aluminum in the early M60s but reverted to steel in later production runs. (Authors)

over a drive sprocket. Once the track was positioned over the drive sprocket the tank's engine was started and placed in "drive", the rest of the tank's crew guided the track over the idler wheels as the driver controlled the speed and applied the brakes as needed. Once the track's ends were both in front of the tank they began the final hook-up. This required the use of the "track jack," which was a screw clamp with hooks on either end. The track jack was placed on either side of the track upon the connecting pins of the track sections. By screwing the jacks tighter the two ends were brought together. Once they were close enough the center guide was installed and the track jacks removed, next the end-connectors were installed, which required the use of a sledgehammer to beat them in place. The final phase of the operation was adjusting the track. The track adjuster was located just forward of the front road wheel. The installing or replacement of a track was also an opportune time to inspect, maintain or replace any damaged road-wheels or road-wheel arms.

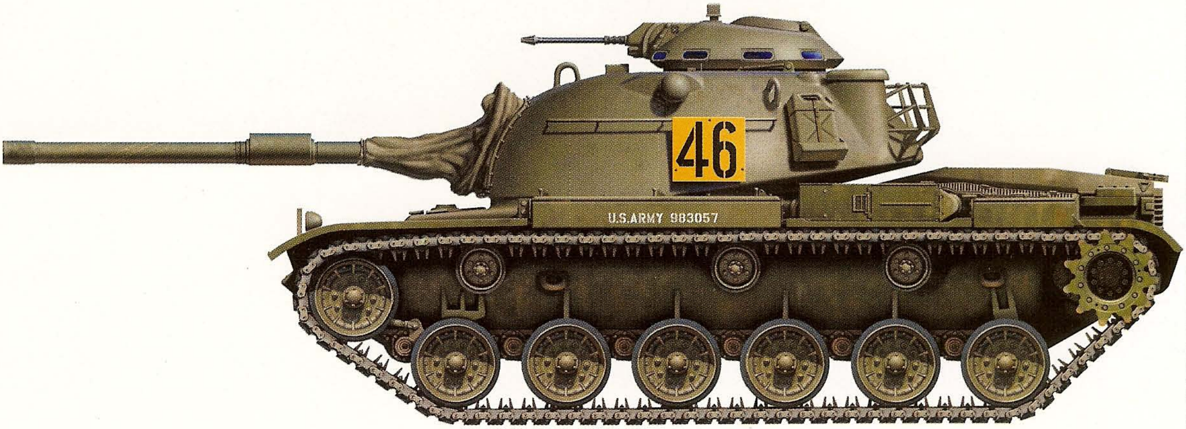


Fuel-fired crew heater exhaust pipe. This occasionally could become clogged and asphyxiate the crew with carbon monoxide if the tank was operating with all hatches closed. To prevent this, the driver's hatch was usually left slightly open when using the heater. (Authors)

"Short-tracking" was a method of repairing a broken track in the field and only done in extreme circumstances. This was done if a track section was broken and could not be reinstalled. To overcome this, the track adjuster was shortened all the way in and one set of road wheels was removed to make the now-shorter track ends meet. This method was used only as a last resort and normally a new section of track was installed.

The power pack maintenance was another task; checking the oil of the air-cooled V-12 was the most critical as with all air-cooled engines. The oil coolers also needed to be cleaned to ensure that they functioned properly. In the event of the pack needing replacement a trained crew could change it in less than four hours and usually closer to two. This of course assumed that the crew had the use of the maintenance unit's recovery vehicle, an M88 or M578, to help lift the upper rear deck and remove the pack and lower the new one into place. The pack removal itself was fairly straightforward. The turret was rotated so the gun tube was directly over the right or left side. The access panel inside the tank forward of the engine compartment accessible through the turret was removed and the quick disconnect connectors undone from inside the tank. The exhaust and intake grilles were opened, the back deck unbolted and lifted up and the final drive disconnected. The pack was now ready to lift

A1: M60 Prototype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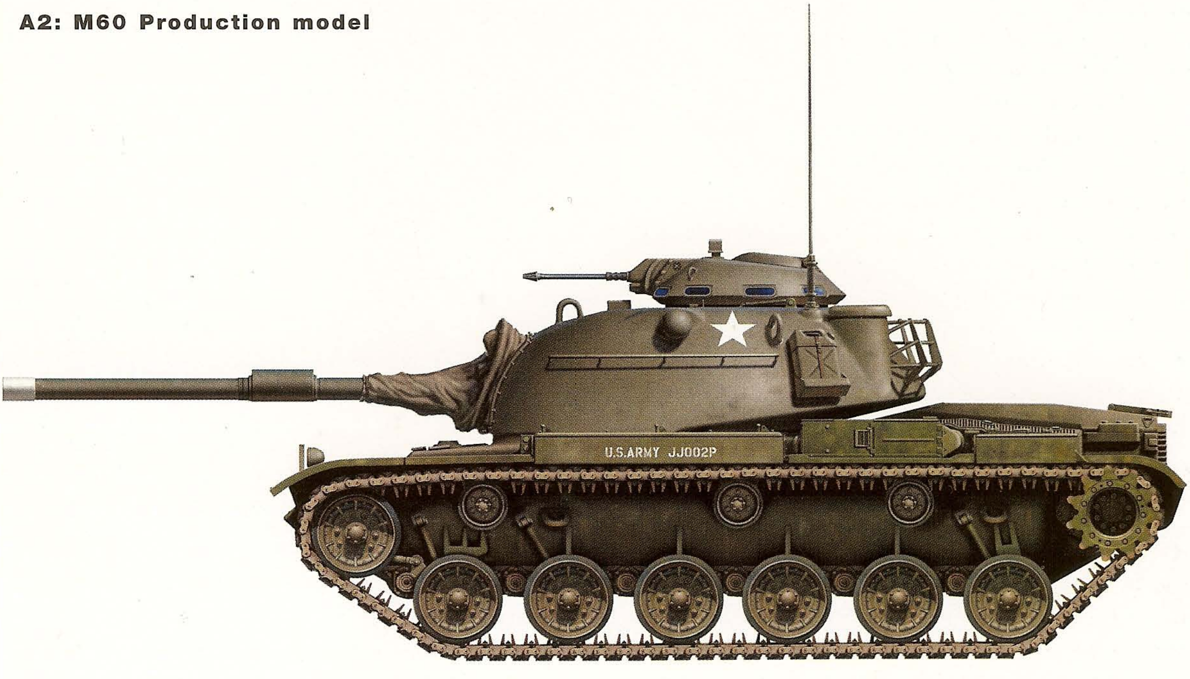
A2: M60 Production model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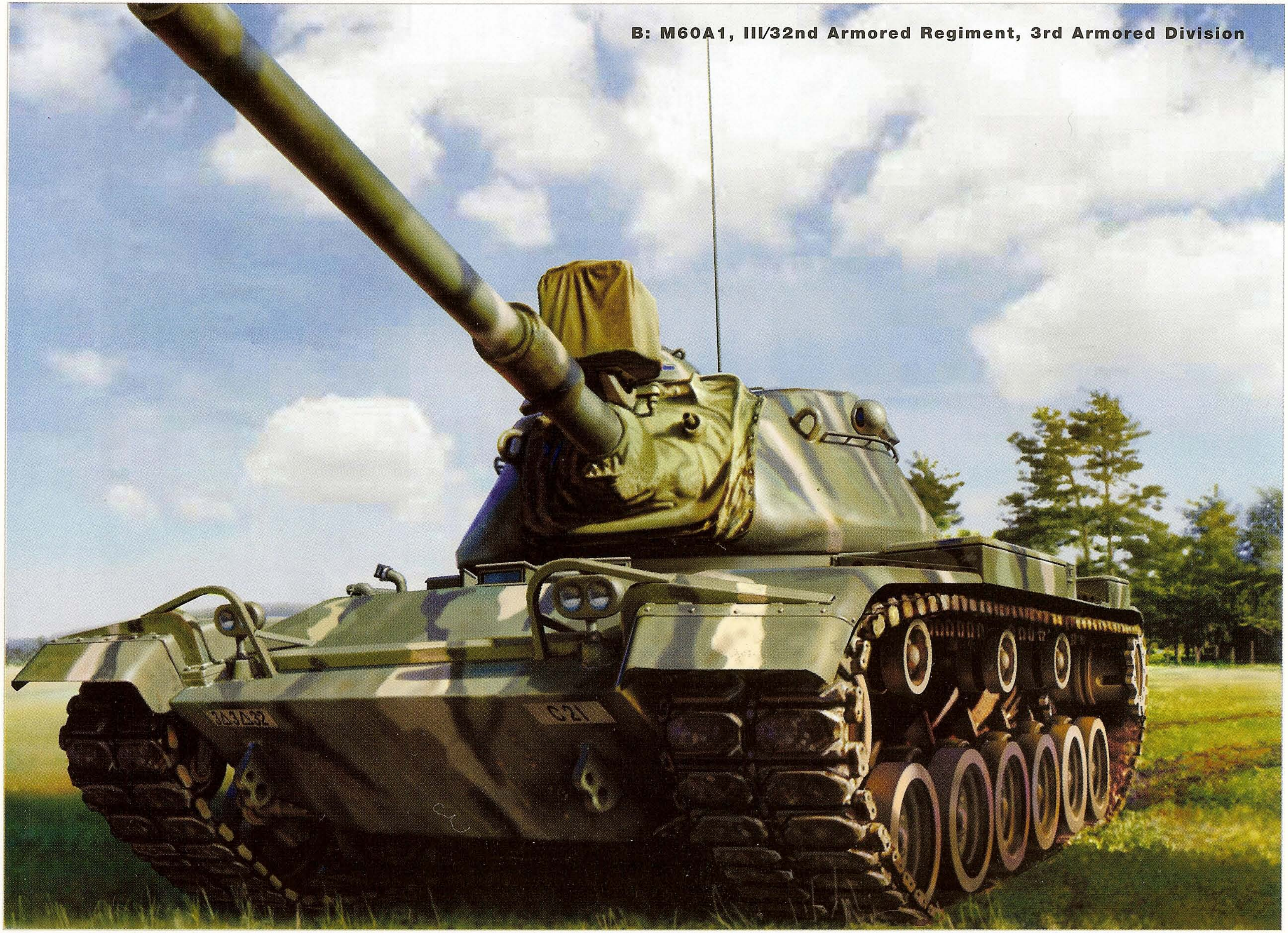
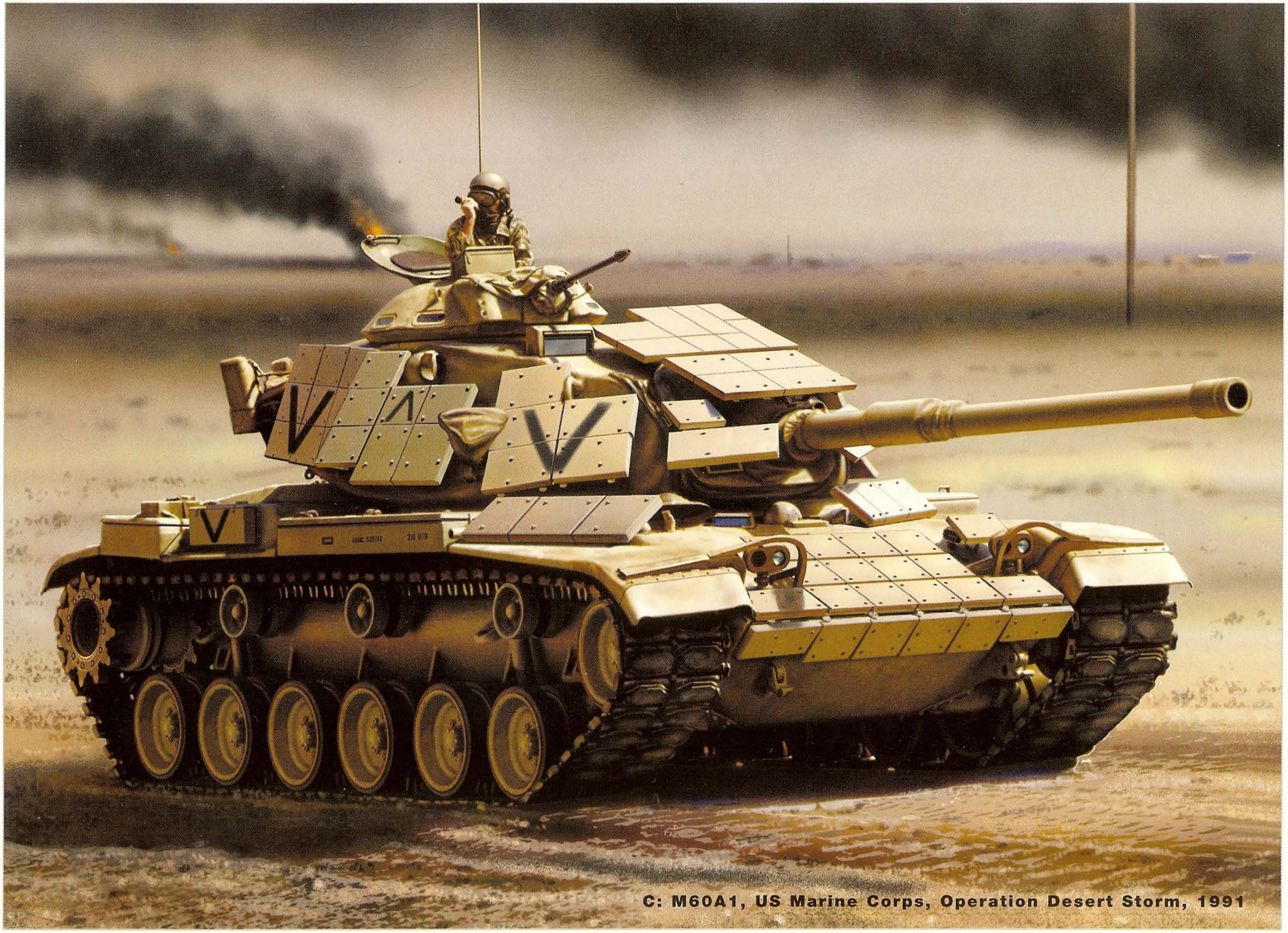


B: M60A1, III/32nd Armored Regiment, 3rd Armored Division



C: M60A1, US Marine Corps, Operation Desert Storm, 1991

D: M60A3 (TANK THERMAL SIGHT)

KEY

1 Fire extinguisher
2 Driver's periscope
3 Tachometer
4 Driver's steering T-bar
5 Brake pedal
6 Accelerator pedal
7 Lifting eye
8 Headlight
9 Transmission selector lever
10 Track
11 Driver's seat
12 Road wheel
13 Return roller
14 Gunner's ammunition selector
15 Gunner's controls
16 Ballistic computer
17 Sight blister
18 Commander's AN/VSG-2 tank thermal sight viewer
19 Turret traverse hydraulic motor
20 Commander's turret traverse control
21 Commander's seat
22 Stowage bin
23 Radios
24 Air cleaner
25 Idler arm
26 Stowage bin
27 Infantry telephone
28 Final drive
29 Engine
30 Turret ventilator
31 Wind sensor mast location
32 105mm ammunition storage tubes
33 Loader's seat
34 Coaxial machine gun ammunition storage bin
35 Commander's laser rangefinder controls
36 M36E1 sight
37 M36E1 sight head
38 AN/VVG-2 laser rangefinder
39 M85 machine gun
40 Tank thermal sight
41 Bore evacuator
42 M68 105mm main gun

SPECIFICATIONS

Combat weight 116,000lb (52,617kg)
Ground pressure 12.37lb/in.^{2} (0.87kg/cm^2)

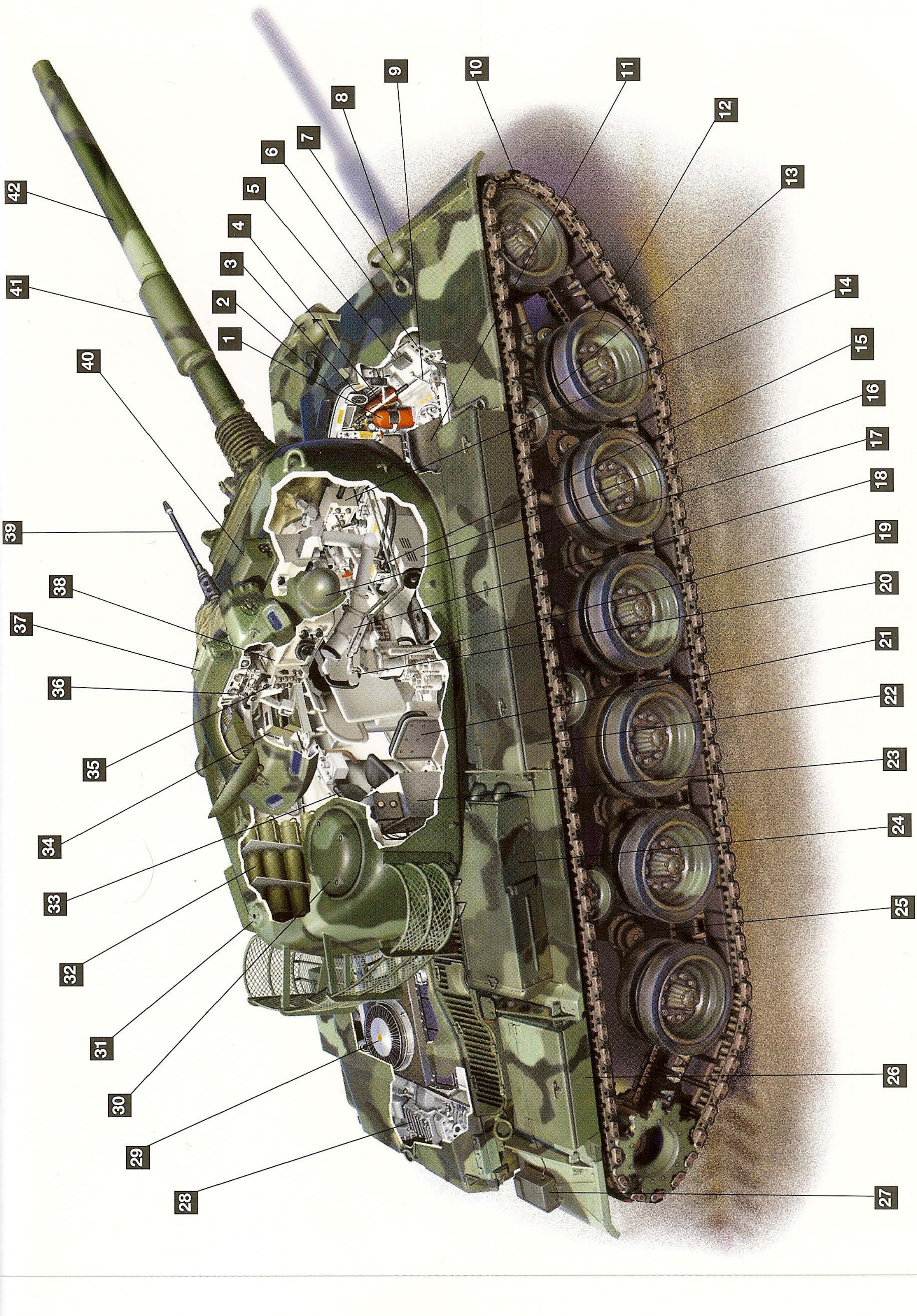
Dimensions
Hull length 22ft 9in. (6.95m)
Length with gun forward 30ft 11in. (9.44m)
Width 11ft 11in. (3.63m)
Height 10ft 9in. (3.27m)
Length of track on ground 13ft 7in., (4.24m)
Track width 28in. (711mm)
Ground clearance 18in. (457mm)
Motor Continental AVDS-1790-2C 1790 Cubic Inch (29.34 liters), air cooled V-12 4 stroke multi-fuel engine 750 horsepower at 2,400 revolutions per minute
Final drive Allison CD-850-6/6A powershift crossdrive transmission 2 forward/1 reverse speeds
Power-to-weight ratio 14.24hp/metric ton
Suspension 6 road wheels per side with 3 return rollers. Road wheels mounted to torsion bars via idler arms

Performance
Maximum speed 30mph on road, 10mph cross-country
Radius of action, road 298 miles (480km)
Fuel capacity 375 US gallons (1,420 liters)
Obstacle clearing, vertical 36in. (.91m)
Obstacle clearing, trench 8ft 6in. (2.59m)
Fording depth without preparation 48in. (1.22m)
Fording depth with fording kit installed 7ft 10in.
Gradient climbing 60 percent

Armament
Main 105mm M68 rifled gun with vertical breechblock
Coaxial 7.62mm M240 machine gun
Commander's 12.7mm M85 machine gun

Ammunition stowage
Stowed
Main 63 rounds
Coaxial 900 rounds
Commander's 900 rounds

Sights, used by commander and gunner
AN/VVG-2 ruby laser rangefinder
AN/VSG-2 tank thermal sight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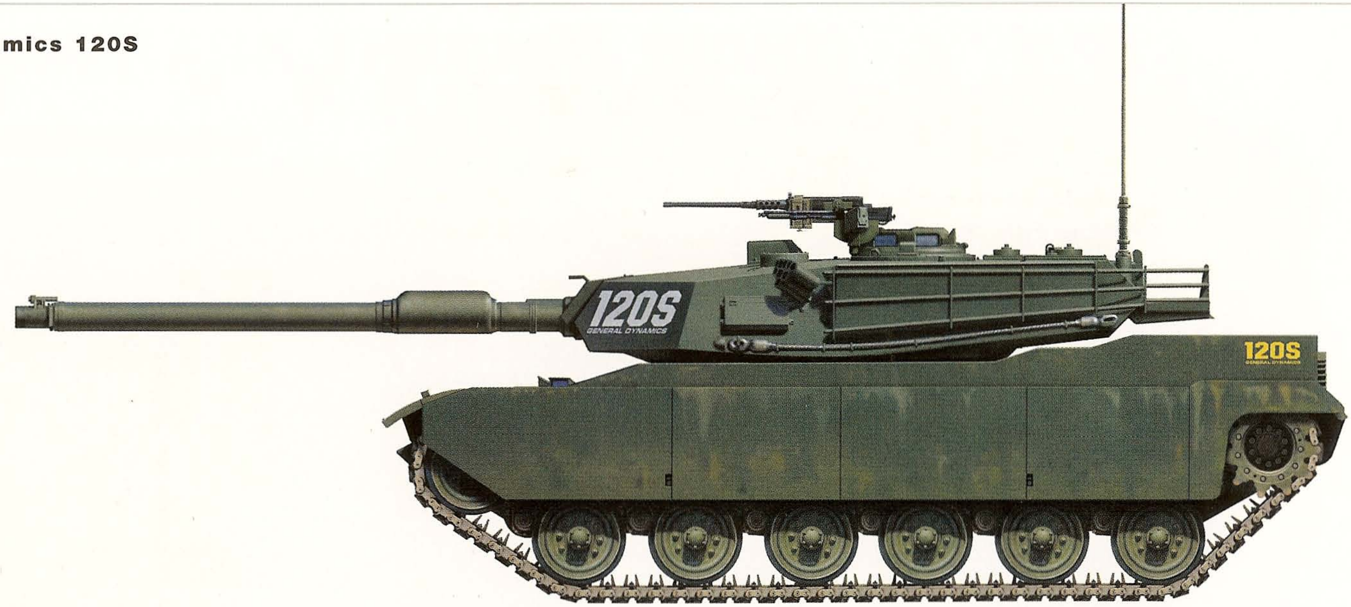
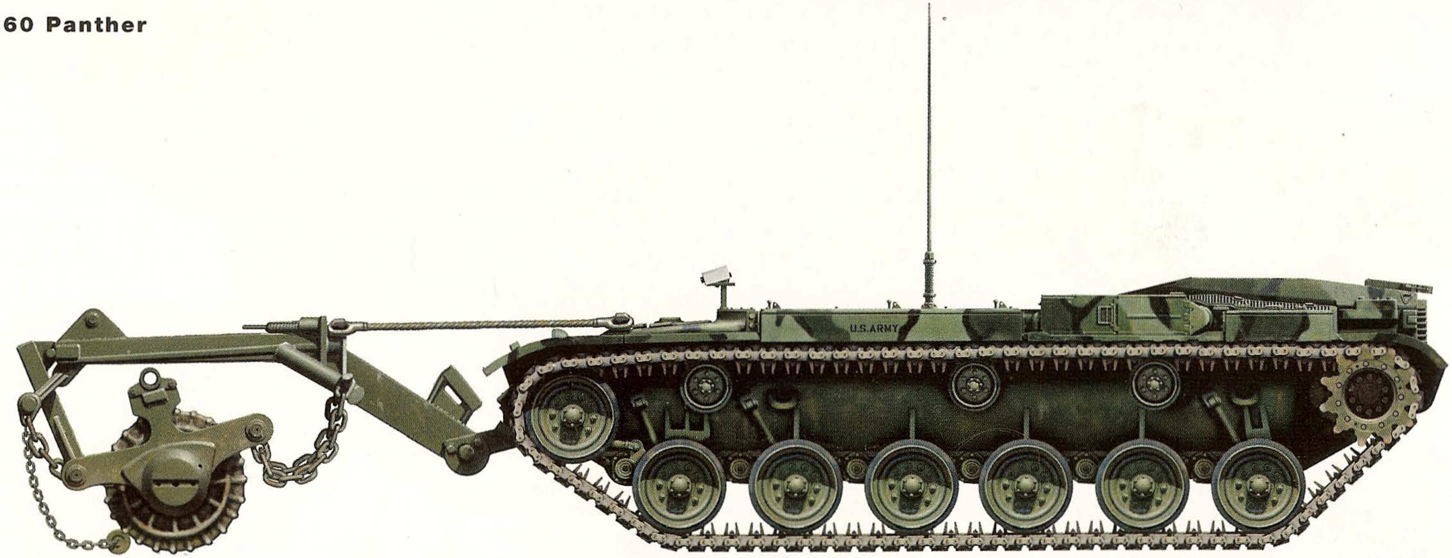
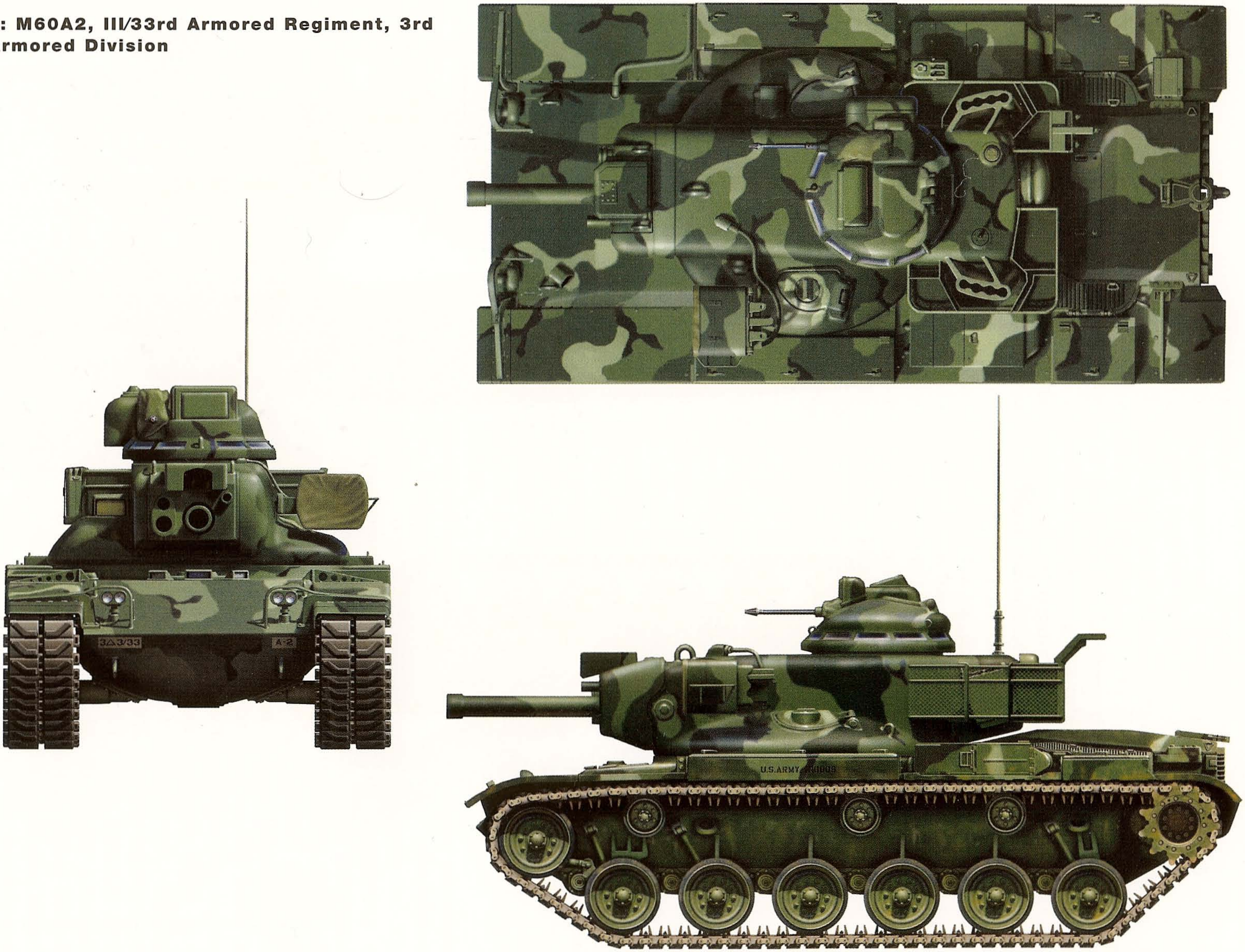
E1: General Dynamics 120S


120S
GENERAL DYNAMICS
120S
GENERAL DYNAMICS

E2: M60 Panther



F: M60A2, III/33rd Armored Regiment, 3rd Armored Division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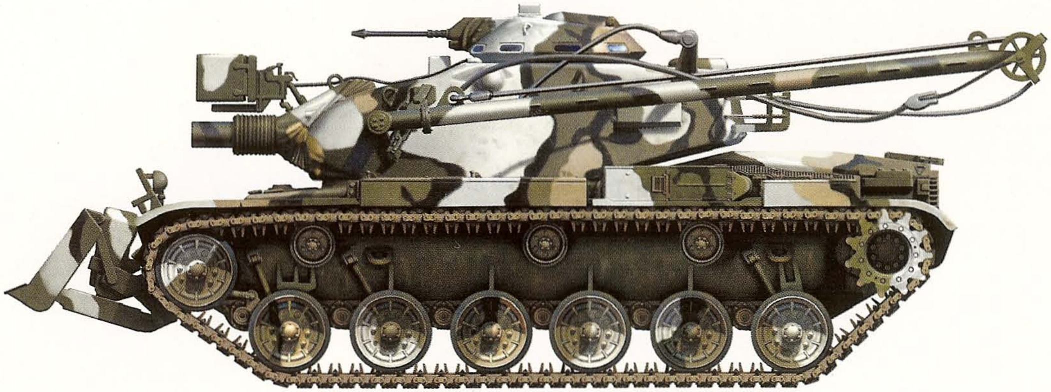
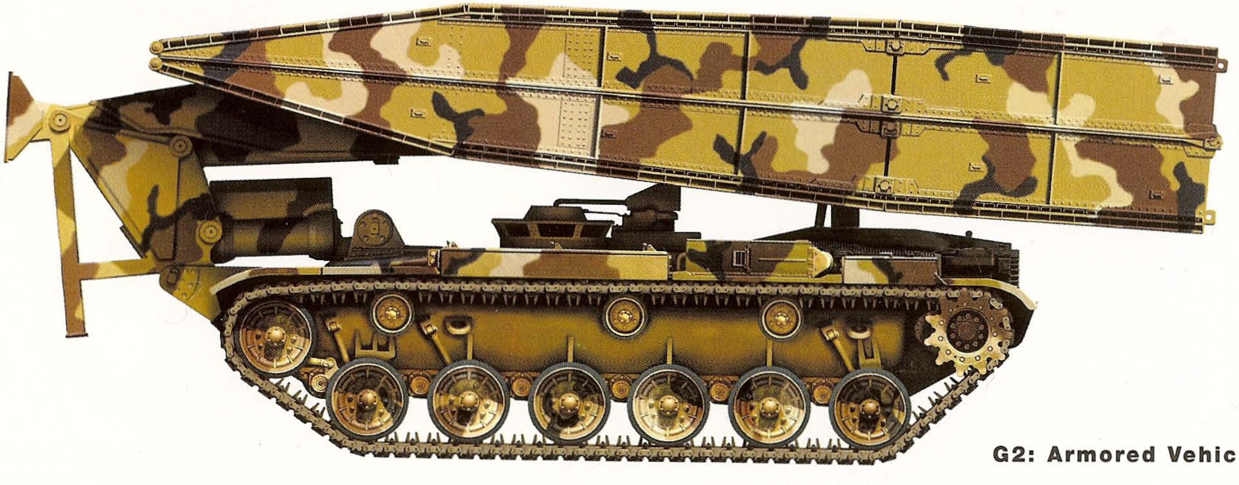
G1: M728 Combat Engineer Vehicle





G2: Armored Vehicle Launched Bridge

out of the hull. Once the pack was out, the inside of the engine compartment was cleaned and inspected before the new replacement pack was installed.

Weapon maintenance was equally critical. The M85 and M73 machine guns were handled very much the same way as any soldier's weapon. The M68 105mm was a little more difficult due to its size. The gun tube needed to be cleaned, or "punched," as soon as possible after a day's firing to prevent it from pitting from the fired ammunition residues. In addition to cleaning the tube, the bore evacuator also needed to be removed and cleaned. The breechblock also required cleaning and servicing to ensure that it was properly lubricated. The gun tube also needed scoping with the use of the special piece of equipment called the "bore scope;" this was usually an annual event. The scope would be inserted into the muzzle of the gun tube and the inspector looked through the scope to inspect for excess wear cracks in the rifling of the barrel. Then the barrel was gauged to determine the amount of life left in the tube. The gun tube's life was recorded in the M60's logbook. On average the life was about 500 rounds and once a tube had reached that point it would be replaced with a new one.

THE 1970s, TIME OF CHANGE

By 1970 the US Army was equipped with M60s, M60A1s and the new M60A2s, while the National Guard units had M48s and M60s. The M60A2, introduced in 1974, proved to be far less significant than envisioned by the army planners. Originally conceived in 1959 and planned to be in production by 1965, this tank was equipped with a guided missile system for armored vehicles. The new variant was designated M60A1E1 and it was envisioned that the weight savings from the removal of the main gun would result in smaller and lighter tanks being fielded.

The Aerospace division of the Ford Motor Company was awarded the contract to develop the new system in June of 1959, although production did not begin until 1973. Ford developed the XM81 Shillelagh 152mm gun/launcher with an infrared tracking and command system for guiding the missile to its intended target. The 152mm gun/launcher system required a separate breech to fire each type of ammunition. It was hoped that the new system would be used on the M551 and the MBT70 that were then still in development. The M60A1E1 conversions took place at the Chrysler Tank Plant in Warren, Michigan, between 1973 and 1975 by replacing the M60A1 turret with the new E1 turret. This new variant was called the M60A2. The army planned to replace all the turrets on its existing M60 fleet and convert them to the new gun/launcher system of the M60A2, this was the only major diference between the M60A2 and the M60A1. The M60A2's turret was a complete redesign from

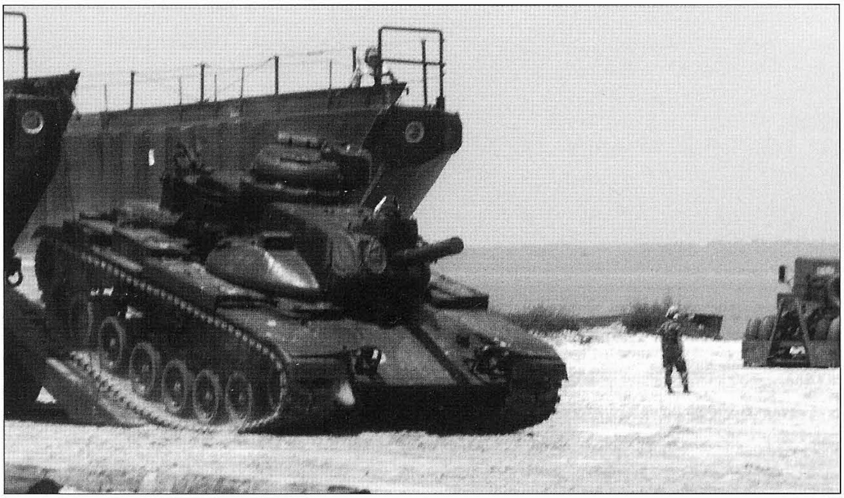
Until Chrysler sold their defense division to General Dynamics in the early 1980s, they produced the M60 series for the US government. This plate was affixed to the rear of the vehicle. (Authors)

CHRYSLER
CORPORATION
DEFENSE OPERATIONS
DIVISION
DETROIT, MICHIGAN

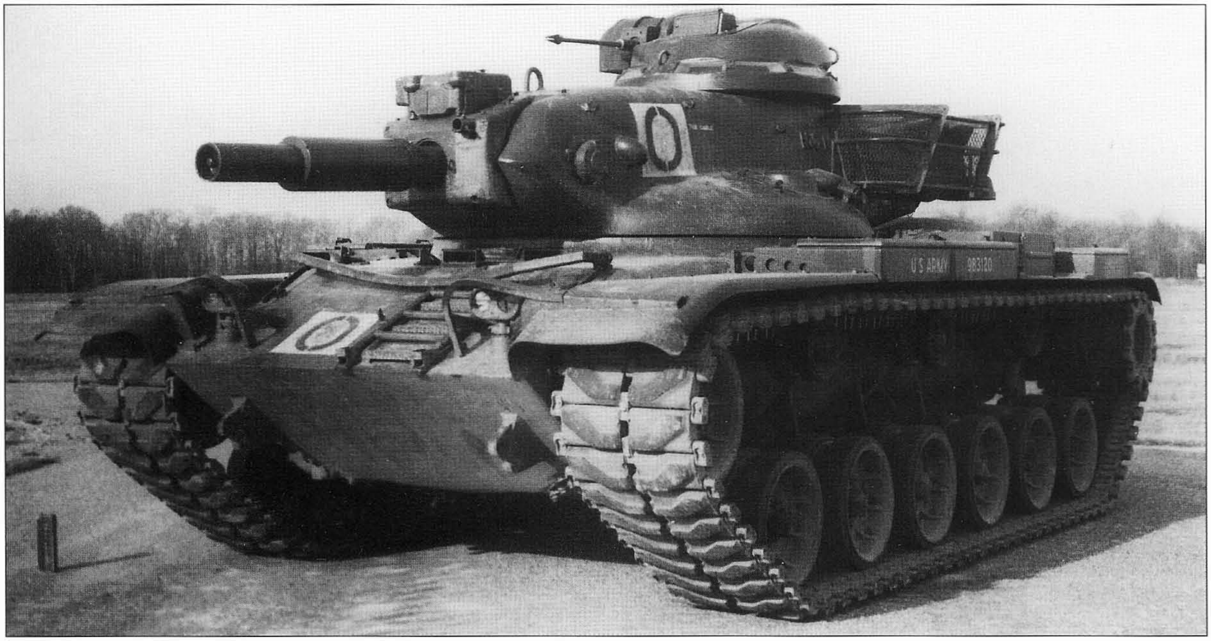
the original M60, with a normal base and a long narrow channel upper portion and an odd looking sight. The commander sat in an elevated position to the rear of the turret, the gunner and loader sat to each side of the channel but lower in the turret into the hull. The M60A2 mounted the first laser rangefinder, which became standard in later tank designs. This first laser rangefinder worked well during daylight operations, but less successfully at night. During night operations the laser rangefinder was only effective to 600m with 25 percent moonlight available. To correct this shortcoming a special filter was added to the Xenon searchlight to improve the laser's effective distance. However, the 152mm gun/launcher system never lived up to the expectations of the army planners. The 152mm gun's breech mechanism failed and leaked into the turret compartment when fired, and other problems with ammunition misfires and premature detonations plagued the system. This was caused by burning residues from the combustible case ammunition remaining in the breech after firing and setting off subsequent rounds as they were placed in the breech. To correct this problem a compressed-air, or scavenging, system to blow the residue out of the gun/launcher was installed. The same compressed-air system was added to the M551 Sheridan since both the M60A2 and the M551 used the same gun/launcher system. Most of the M60A1E1's glaring problems were resolved and it was officially designated as the next US Army's Main Battle Tank or MBT in February 1965. However, this new MBT's testing and evaluation continued until actual production began.

A total of 526 M60A1 tanks were eventually pulled aside from the normal production line and placed in the M60A2 (formerly the M60A1E1) production line and converted to the new configuration. The M60A2 production ran side by side with the M60A1 tanks from 1973 to 1975 when production of the M60A2 ceased. Deployment of the new A2s to army units in both the US and Europe continued to be beset with problems and they were never very popular with the troops or their commanders, being finally withdrawn from service in 1980. After the phasing out and decommissioning of the M60A2s the empty slots were replaced by standard M60A1s. Meanwhile the M60A2s had their turrets removed and scrapped, while the majority of the A2's chassis were then converted to AVLBs. Due to the fact that the basic M60 chassis was used for various upgrades, it is very difficult to verify actual M60/M60A1 production numbers as these same chassis were upgraded, retrofitted or reconfigured several times in their lifetimes.

As the M60A2s were being phased out and the latest version of the M60A1 was rolling off the production line a new MBT was being tested, the MBT70.



Taken in 1985 at a logistics exposition, an M60A2 comes ashore from a LARC 60 landing craft. The M60A2 did not last in service long due to the complexity of the fire control systems. (DVIC)

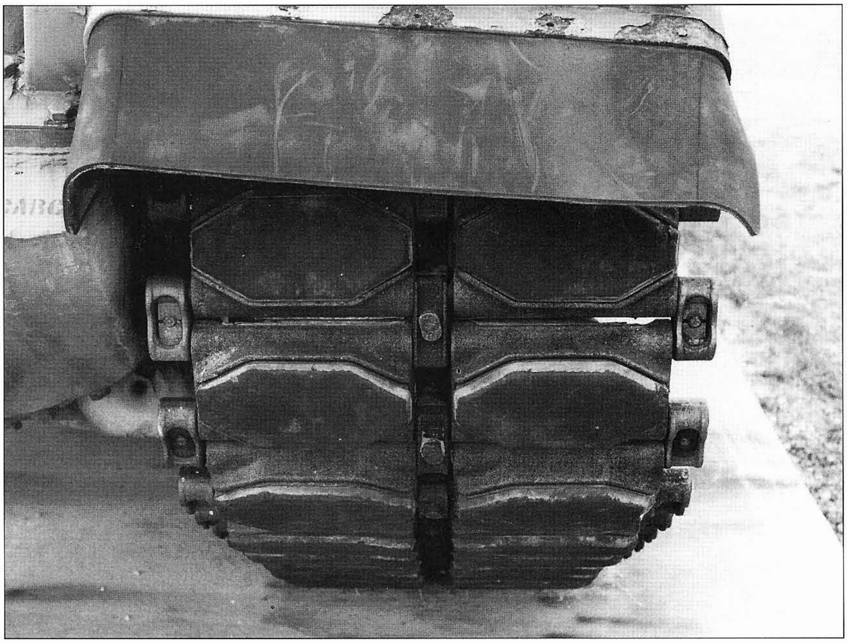


M60A2 was an attempt to increase the lethality of the M60 series with minimal investment by the use of a guided 152mm missile. The minimal cross-section of the turret was intended to increase the tank's survivability on the battlefield. (NARA)

The MBT70 concept that had been envisioned nearly 20 years before was finally starting testing and would soon develop into the M1 tank. For now the M60A1 was the mainstay of the US Army armored command, and set the standards for any future tank.

The Foreign Military Sales (FMS) of the M60, M60A1 and converted M48s had taken place for several years by this point and with these exports came important feedback for future improvements of the M60A1 and future tanks. FMS sales during the life of M60 included sales to Austria, Bahrain, Egypt, Ethiopia, Greece, Iraq, Iran, Israel, Italy, Jordan, South Korea, Oman, Saudi Arabia, Sudan, Taiwan, Thailand, Tunisia, Turkey and Yemen. Singapore purchased M60 platform vehicles the M728 CEV and M60 AVLB; Spain also purchased a number of M60 AVLBs.

M60A1s exported to Israel proved to be the source of the most valuable. The bulk of this information came from the Arab–Israeli conflict in 1973 known as the Yom Kippur War, which drew a lot of attention from the world, especially from US military planners. The Israeli forces were heavily outnumbered and virtually surrounded but were able to push the attackers back and gain ground, mainly due to the intensive training of their military and the courage of their tank crews and at a heavy loss. These heavy losses of Israeli equipment, as well as concern over the welfare of the future state of Israel itself, caused the US to rush replacement equipment from its reserve stockpiles, which included a large number of M60A1s. The after-action reports filed by the US Military Liaison Mission in Israel had carefully monitored the Israeli M60s battling against the Soviet-made tanks and were evaluated with great interest. Especially since this was the first time the M60 had actually been in real combat against its intended foe, the Soviet T-54/55 tank. The reports indicated several shortcomings when facing Soviet tanks and anti-tank rockets. As the reports filtered their way through the military analysts' studies, one of the first items of concern was the M60's turret hydraulic oil. Though normally not very flammable it was found from the reports that when an Israeli tank had been hit the hydraulic oil would burst into flame. This was because of the high operating pressure of 1,200 P.S.I. Army researchers scrabbled to find a solution and late in 1974 a Maintenance Work Order was released to have the OH-10 Hydraulic Oil, more commonly known as "Cherry Juice" because of its reddish color, replaced with less flammable hydraulic oil that resembled vegetable cooking oil.

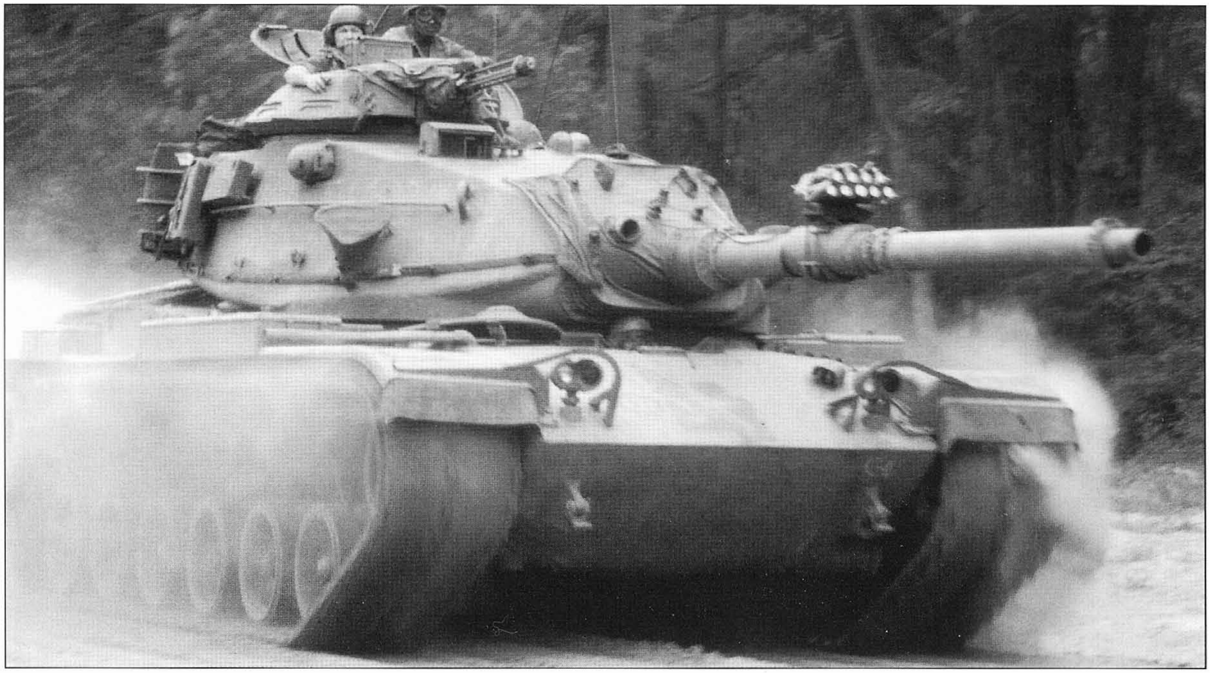


Late M60s featured redesigned tracks with replaceable rubber pads to minimize damage to roads. (Authors)

Additionally, the reports indicated more or thicker armor plating was required, and with the advances in shoulder-fired anti-tank weapons this became increasingly apparent. Increasing the overall thickness of the existing armor on the tank would increase the vehicle's weight and decrease the overall performance of the tank's engine. The solution was a sort of bolt-on appliqué armor plate or protective shielding covering key areas of the tank, and even this would require increased horsepower from the engine to handle the additional weight. The M60A1 needed to be improved to be brought up to these latest ballistic specifications. The need for increased engine horsepower output to handle the added weight of the armor, along with the cancellation of the MBT70 tank program that was slated to replace the M60, only further indicated the need for a more extensive upgrade to the tank. Though the M60 had originally been envisioned as a short-term replacement until a true new NATO-approved Main Battle Tank could be fielded, project cancellation, budget shortages and military downsizing had resulted in the M60 tank being in its 15th year of service with no immediate replacement in sight.

All this resulted in the development of the M60A3 and production of this variant commenced in 1978. The improvements covered everything learned plus the latest technology available. The T97 track was replaced with the removable pad type T142 track. Next the power pack was upgraded to the AVDS-1790-2C V-12 engine with a 650-amp oil-cooled alternator. The air-cleaner filters were redesigned to be top loaded instead of the old side-loaded models as in the M60A1. The new power pack even included a smoke generator that Israeli and US Army labs had been working on for some time.

The stabilization system was completely redone from the earlier M60A1. The new system added more sensors and inputs to include weather, wind conditions and even barrel wear. A thermal sleeve

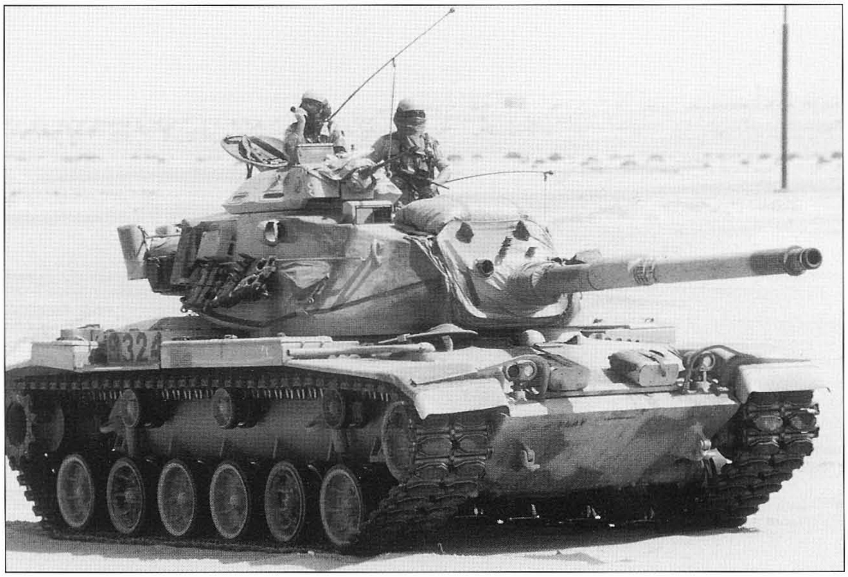


An M60A3 of the Georgia National Guard fitted with MILES training gear. The device on the top of the main gun is a gunfire simulator. The MILES gear used a laser and sensors located on the tank to simulate the effects of tank gunfire on enemy tanks. (DVIC)

covering the 105mm main gun tube was added to counter drooping of the gun tube due to heat generated from firing. The laser rangefinder of the AN/VVG-2 greatly enhanced the system and was connected to the new M21 ballistic computer, which was of solid-state electronics instead of the old gear and cam ballistic computer of the M60A1. With the upgrade of the fire control system this made the old stereoscopic rangefinder obsolete and meant that the periscope heads on the loader's side of the turret had to be ballistically covered. The commander's side periscope head of the M17 was replaced with the new Optic Electronics' AN/VVG-2 ruby laser rangefinder sight.

The M73/M219 7.62mm coaxial machine gun was replaced with the coaxial version of the new M240 machine gun. This was to standardize the machine guns in the military inventory and reduce the amount of spares required to support them. The next upgrade was the addition of a six-barrel grenade launcher system that fired 66mm shells. The grenade launcher system had been in use for quite some time by other nations' armies but the US was slow to see the advantage. The US version of these launchers were able to fire smoke shells only, while most other countries could fire either fragmentation or smoke rounds. M60A3 production numbered 5,400 tanks with 1,700 being new production models while the remainder were upgraded M60s and M60A1s.

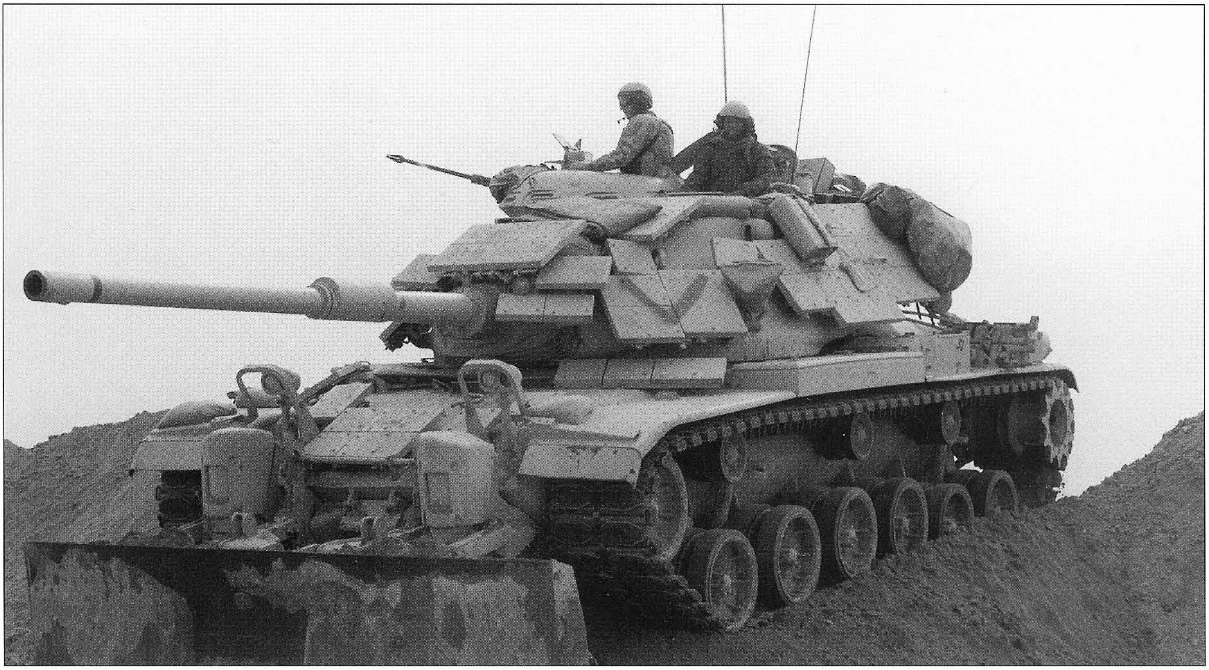
By 1988, bolt-on appliqué armor or reactive armor plates had become a reality. The main reason for the delay, besides budgetary problems, was the overwhelming task of figuring out how to handle the added weight to the tank's chassis. There were safety concerns about explosives in the reactive armor plates, the concern being that an explosive tile could possibly detonate while the crews were outside of the tank or while they had their hatches open. Another concern was that the addition of some 4,000lb to the weight of the tank caused by added armor was a strain on



M60A3 being demonstrated to Egyptian officials in 1983. This tank is carrying extra jerry cans on front of hull and rear of turret basket. The loader is carrying an M3 submachine gun, a World War II weapon still in use by armor crews. (DVIC)

the power pack and the suspension system. The torsion bar and swing arm suspension was at its limit and a new torsion bar system would add even more weight. In the mid-1980s Cadillac Gage Textron developed and tested a revolutionary alternative system that placed the shock-absorbing capabilities all in the swing arm assembly or roadwheel arm. The new swing arm suspension was slightly larger than the original road wheel arm but no longer required torsion bars and this reduced the additional weight required by them. This swing arm had a specially developed hydraulic shock-absorber system built inside the swing arm. These new swing arms were fitted to some of the USMC M60A1s and AAVs with appliqué armor. By this point the US Army was in the process of converting to newer M1 tanks from the M60A3, while the US Marine Corps continued to use the M60A1. Of these, 170 units of the USMC's tanks were upgraded with the new appliqué armor system; these same units later saw action during the Gulf War of 1991.

Global Positioning System, or GPS, which was introduced in the late 1970s, was quickly seized upon by the US Army. By the 1980s commanders could have firsthand knowledge of where their units were located across the battlefield. To accomplish this GPS transmitters



Taken in Saudi Arabia during Desert Storm, this Marine M60A1 is fitted with Blazer reactive armor and an M9 bulldozer kit. The dozer kit consisting of a front-mounted blade was used to breach Iraqi berms around Kuwait. (DVIC)

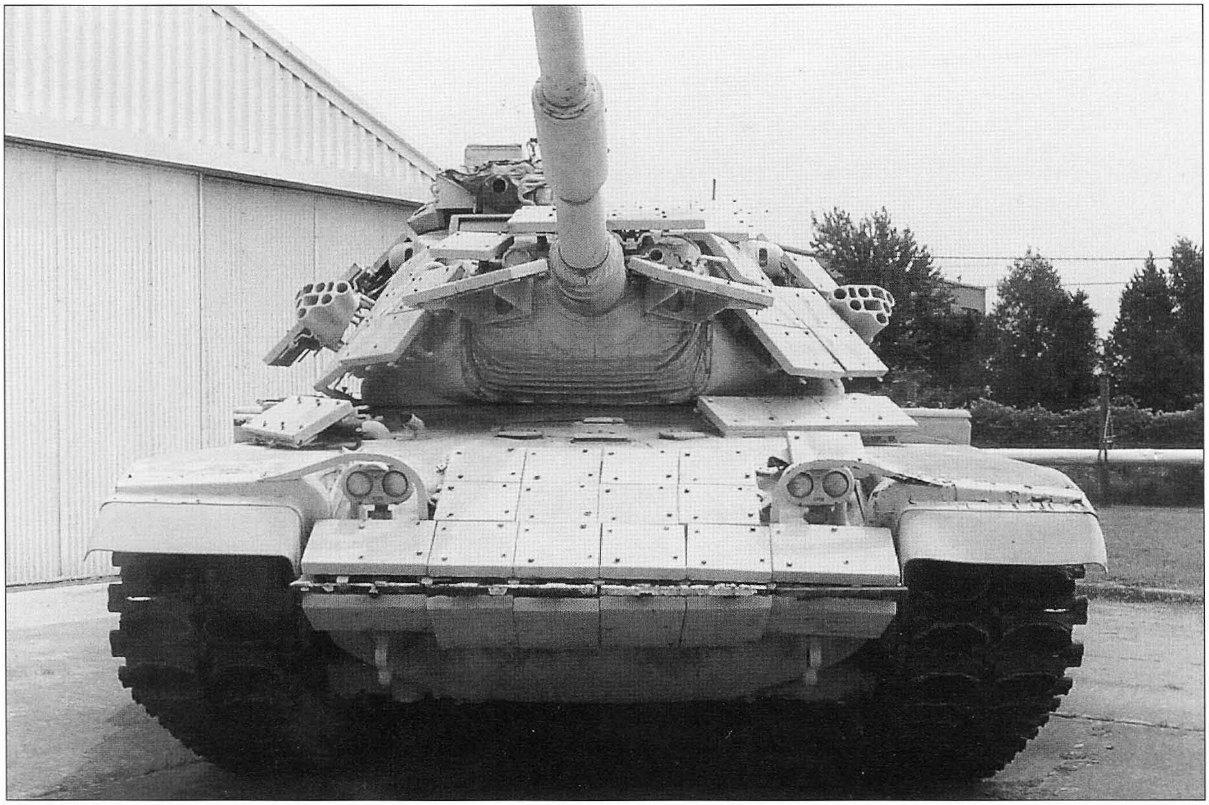
LEFT **Marine M60A1 at Beirut Airport, Lebanon, fitted with a fording snorkel for amphibious operations. Marine M60s were fitted with amphibious gear as part of their basic configuration due to the nature of the Marines' role as amphibious assault troops. (DVIC)**

were installed onto armored vehicles, including the M60 tanks, which transmitted their locations back to the command center. Various systems were tested at the US Army's Desert Training Center, California, and several annual training exercises conducted in Europe, Egypt, Israel and Saudi Arabia. In the desert the GPS proved its worth not only for the unit commanders but also for the tank commanders themselves given the task of maneuvering across a featureless desert terrain where one sand dune looks the same as the last one.

Further development of the US military's M60 fleet was canceled in 1988 when it was considered more prudent to focus on the M1 Abrams Tank Program, which had been in production since 1981. However, improvements continued to be done to the M60 tank mainly for foreign military markets.

In 1991 during the Gulf War against Iraq the US M60 tanks were finally in combat with US soldiers at the controls against the foe they were designed for: the T-55, T-62 and T-72 Soviet-made tanks. US Marines manning the M60A1s reported no problem defeating Iraqi Soviet-made tanks. They even reported destroying a T-72 with an APFSDS round that went through the front and exited via the engine, although this was accomplished at short range. The M60's accomplishments were overshadowed by the US's newer M1A1 tanks. But the M60A1 and M60A3 did make their way into the American history books as being part of the Allied coalition in Operation Desert Storm, where an M60A3 was the first tank to enter Kuwait City with the US Marines.

With the adoption of the M1 tank further development of the M60 was stopped. As frontline units began to transition from the M60 to the M1, so US Army Reserve and National Guard units were also being upgraded and their old M60A1 units were sold or donated to foreign governments. Interestingly the decision to terminate the development



Frontal view of one of the first Marine M60s to enter Kuwait City in 1991. Due to the increasing lethality of explosive anti-tank warheads against the ageing M60 armor, Marine M60s were fitted with supplementary armor to counter anti-tank missiles. (Authors)

of the M60 by the US Army came one year short of the fall of the Berlin Wall and the end of the Cold War. With the ending of the Cold War, the US Government sought to shrink the size of the military in order to save money. This resulted in entire divisions of armored and support units being deactivated. The scaling down of US forces also resulted in the M1 tank being deployed to Army Reserve and National Guard units shortly after they had transitioned to the M60A3s. In order to dispose of the large fleet of M60s, and due to the restrictions of the Conventional Armed Forces in Europe (CAFE) treaty, the US Government began to transfer large amounts of its M60A3s to governments around the world. The foreign governments were only able to take so many of the 7,400 M60 tanks that were produced. In order to comply with the CAFE and to dispose of the remaining fleet, it was decided to utilize the tanks as artificial reefs around the US coastline. The plan, called REEF-EX, required the removal of the power pack and the steam cleaning of the hull to remove any hazardous substances. The crew hatches were welded shut to prevent curious divers from being trapped within the sunken hulls. The tanks were then taken to the site by barge and dropped into the ocean by a crane. The waters off the eastern coastline of the United States received a great number of M60s and M551s under this program. This was a truly sad end for a valiant warrior of the Cold War. Another way of disposing of the surplus vehicles was a large-scale donation of M60 tanks to various Veterans organizations, American towns and museums that requested them as monuments. The less fortunate tanks finished out their operational lives as targets for live fire exercises on firing and bombing ranges.

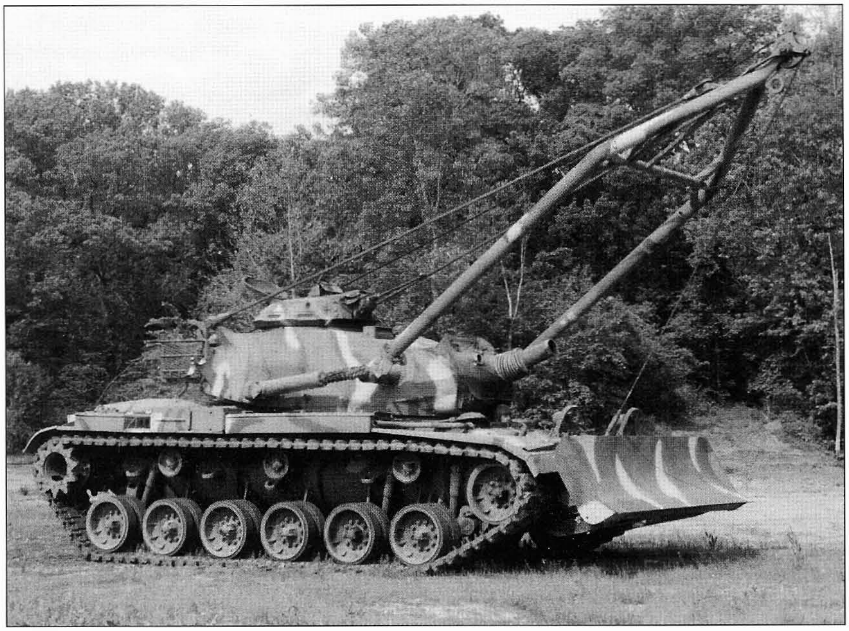
The last US Army unit to possess the M60A3 was the 1st Battalion of the 365th Armored Company of the Kansas National Guard, which replaced their trusted M60s with M1A1s in May 1997. After nearly 40 years of continuous service in the US Army the M60 era came to a close. While no longer a part of the US military's inventory the M60 continues to serve other governments around the world. Due to the cost of designing and fielding a new tank many defense companies have developed upgrade programs for the M60 tank that are more suitable to the budget and limited resources of some foreign governments. For example, the Israeli M60s have seen the most adaptations over the years with everything from 120mm smoothbore main guns to commander and loader external machine gun mounts, mine-clearing and even modified dozer blades added.

General Dynamics Land Systems, who purchased the Chrysler Defense Division in the early 1980s, developed the 120S in response to a Turkish request. The 120S mated an M1A1 120mm turret with the hull of the M60. A new AVDS-1790-9 engine provided 1,200 horsepower to compensate for the new load. The tracks, suspension, final drives and transmission were upgraded to the same components as used on the M1 tank. Sponson boxes and side skirts were added to the sides of the hull, which changed the profile of the M60 tank to resemble the M1 tank and also provided additional armor protection. As of 2002, the 120S has not been accepted by the Turkish Land Forces, which have gone to the world's leading tank manufacturers for a new tank contract bid. Testing continues in Turkey of several other options for a replacement of their ageing tank fleet including the Israeli variants of the M60.

Another adaptation of the M60 tank was a conversion into a crewless remote piloted vehicle (RPV) by the Omnitech Corporation. The conversion of the tank entailed the removal of the turret and the installation of the Standardized Teleoperation System. An Israeli-designed mine roller was fitted for mine clearing duties. Operation of the RPV was done from another vehicle or from a remote location nearby. Christened the Panther, the system was used in Bosnia and Kosovo for removing land mines in that war-torn region.

The M60, though originally envisioned as a stopgap solution to an immediate threat, went on to serve around the world. The M60's size, though considered large on the battlefield, gave space and adaptability for the numerous upgrades

Developed for the Army Engineers, the M728 Combat Engineering Vehicle (CEV) is fitted with a boom, bulldozer blade, winch and 165mm demolition gun firing a high-explosive round to remove and destroy obstacles. (DVIC)



and modifications that were done to it over the years. It has become an enduring icon of the US military's presence in Europe and of the Cold War. The M60 is still considered to be one of the best main combat tanks to date and it will remain in service around the world for some time to come.

M60 VARIANTS

The M60 tank chassis soon became the standard for the army's combat support vehicle fleet. These variants were an armored bridge laying vehicle and a combat engineering vehicle. Though the M60 tank is no longer in the current US military inventory these M60 variants continue to serve with no replacements planned for the near future.

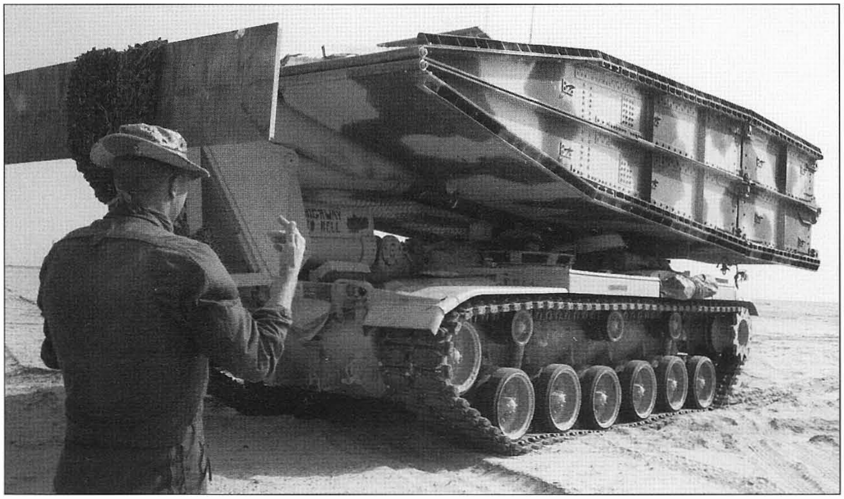
M728 Combat Engineer Vehicle (CEV)

The M728 was based directly on the M60 Main Battle Tank, but with alterations designed for engineering in combat conditions. The turret of the CEV has a short-barreled XM-135 165mm gun (patterned after the British L9A1 gun) instead of the 105mm gun. The 165mm gun fires a special high-explosive round designed for destroying bunkers and concrete reinforced positions; the range of this round is short but it is very effective against its designated targets. With the introduction of the 165mm gun the ballistic computer, actuator and rangefinder were not required and were removed, which freed up space needed for the new hydraulic components: winch, boom and dozer blade controls. The turret also has a retractable A-frame attached which can be raised from a stowed position over the back deck of the tank to a forward operating position over the front of the tank. A winch mounted on the rear of the turret by having its cable routed through the boom is capable of lifts of up to 17,500lb or directly hooking the winch cable to an object it can pull at 25,000lb.

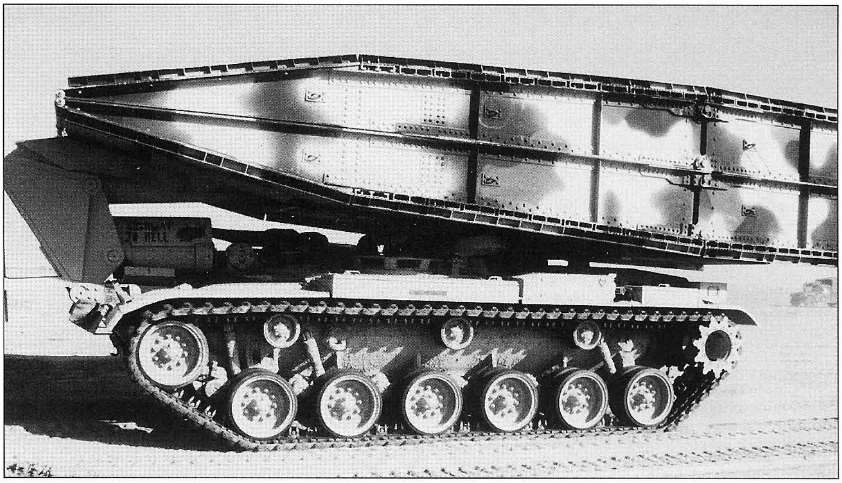
A bulldozer-type blade is fitted to the front of the tank. This addition has been a key feature and is the most commonly used item on the tank. The blade is used to remove obstacles, barricades or combat-damaged vehicles that block the path of advance. The blade is also a labor-saving device and is used for digging fighting positions or stowage pits if the ground is not too rocky. Another valuable use of the blade is to scrape the road surfaces and uproot land mines.

Additionally the M728's boom is another tool for maintenance of its cousin the M60 tank. The boom is used to remove and replace

Taken during Operation Desert Storm, a US Marine Armored Vehicle Launched Bridge (AVLB) maneuvers into position in Saudi Arabia. The AVLB allows the emplacement of a bridge capable of supporting armored vehicles while under fire. (DVIC)



Side view of the AVLB showing the mechanism for raising and emplacing the folded bridge. The bridge is stored in a folded position. During the emplacement process it is raised vertically and unfolded. The bridge is emplaced and the launcher drives away. The AVLB crew can emplace and retrieve the bridge from within the vehicle. (DVIC)



the power pack of the M60 when an M88, M578 or wrecker truck is not available.

M60 Armored Vehicle Launched Bridge (AVLB)

The AVLB is essentially an M60 without the turret: in its place is a scissor folding bridge that can span gaps of up to 60ft. When a stream or ditch is encountered that the tanks cannot cross the AVLB is called in. The bridge layer approaches the obstacle and opens the folded bridge, an action resembling a snake raising its head from a coiled position. As the bridge straightens out, it becomes one long span that can be placed over the barrier. Once in place, the connecting pins that attach the chassis to the bridge span are removed and the chassis can drive out of the way to make room for usage of the temporary bridge. The deployment of the folding bridge can take as little as three minutes with an experienced crew. When the crossing is complete the AVLB reconnects to the bridge span, folding it up again and moving on to the crossing site. If the bridge is still needed, additional bridges are available from the depot for the AVLB to carry.

The AVLB is a prime example of cost savings; the chassis or track portion of the vehicle was adapted from whatever was available at the time, with chassis types ranging from M48s to M60A2s. The conversion consisted of upgrading the power pack and tracks, removing the turret completely and replacing it with the hydraulic and bridging components.

Due to the forecasted cost of replacing the AVLB, as of 2002 it is predicted that the AVLB will remain in the US Army inventory until 2015 and beyond.

M88 recovery

The M88, though not a true variant of the M60 family, was an integral part of the M60 fleet. If there were M60s deployed so too were the M88s. The M88s did share a few common parts with the M60s, mainly the suspension components such as road wheels and track.

Each M60 tank company's maintenance section had an M88 in its inventory and with the extensive maintenance required on tanks the M88 saw nearly daily usage. The M88 was required to tow or push disabled M60s besides being used to lift the power packs of the M60. In addition to the routine duties of the M88, its blade became useful for such things as removing snow from roads or digging out stuck vehicles.

M60 family production numbers

M60 – Main Battle Tank – 2,205 produced from 1959 to 1963, some of which were converted M48s.
M60A1 – Main Battle Tank – 7,653 produced from 1963 to 1978, including conversion of earlier M60s.
M60A2 – Main Battle Tank – 526 produced from 1974.
M60A3 – Main Battle Tank – 5,000 plus produced from 1978 to 1987, most of which were FMS or Foreign Military Sales from 1980 onward. Some included the conversion of a few M60A1s.
M60A4 – Main Battle Tank – Proposed for US National Guard M60A3s.
M60-2000 – Main Battle Tank – Proposed for export.
M60AVLB – Armored Vehicle Launched Bridge.
M728 CEV – Combat Engineer Vehicle.

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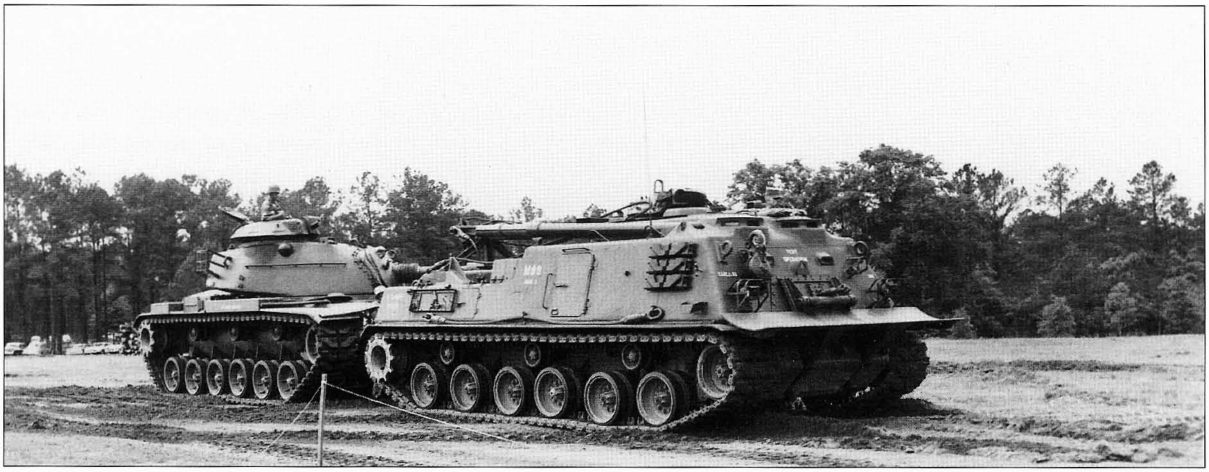
M88 tank retriever towing an M60. The M88 shared suspension components with the M60 series. After going through numerous upgrades in its life cycle, the M88 is still used for recovery of the M1 series of tanks. (NARA)



COLOR PLATE COMMENTARY

A1: M60 PROTOTYPE

Responding to intelligence reports of the new Soviet T-55 tank, the US Army sought to upgrade the M-8 series of tanks to be able to defeat the new threat. The British-designed L7 105mm tank gun had already proven itself in testing to be able to defeat the armor thickness of the T-55 and was installed into an upgraded M48 turret.

The new M48 version now christened the M60 featured a new diesel engine, the first installed in a US tank in regular service, aluminum road wheels and a new commander's cupola.

A2: M60 PRODUCTION MODEL

The M60 was placed into production in 1960 with the first units being assigned to frontline troops mainly in Europe. Troop trials had shown that the prototype M60's suspension was not able to sufficiently absorb the shock of cross-country travel. In order to address this concern shock absorbers were added to the 1, 2 and 6th road wheel station.

This tank followed the standard color and marking practice for the US Army in the 1960s, being painted semi-gloss olive drab overall with flat white national insignia carried on the turret and with US Army and vehicle registration number carried on the side of the stowage bins mounted on the running boards of the tank.

The initial production units of the M60 were issued to forces stationed in West Germany opposite the Warsaw Pact.

Many of the early-production M60 tanks were upgraded to later models.

B: M60A1, III/32ND ARMORED REGIMENT, 3RD ARMORED DIVISION

In order to improve on protection for the crew and the vehicle and to give additional room for 105mm ammunition, radios and the new 105mm main gun, the US Army redesigned the original M60 turret. The new turret moved the main gun forward 6in and was of a new shape.

An improved engine and automotive features were also added to the new model. A Xenon searchlight mounted above the main gun aided engaging targets at night.

The M60A1 began to be fielded to frontline US units in 1962 and was produced up until 1980.

This vehicle is illustrated as it would have appeared in Western Europe during the later 1970s. In 1975 the US Army began to use a four-color camouflage pattern on its vehicles. The vehicle is painted using the US & Europe Summer Use camouflage pattern of Forest Green and Light Green, Sand and Black. The vehicle is marked as being from the 3rd Battalion, 32nd Armored Regiment, 3rd Armored Division.

C: M60A1. US MARINE CORPS, OPERATION DESERT STORM, 1991

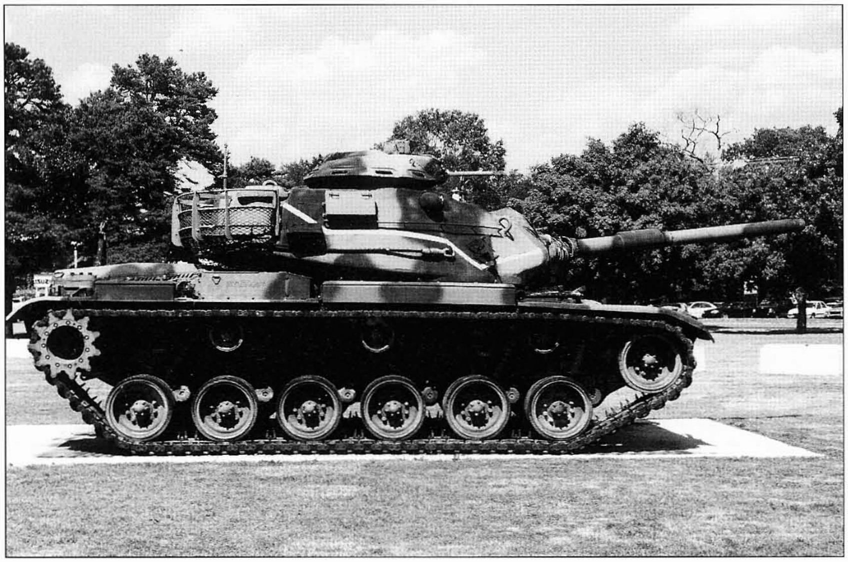
By 1991, the US Marines were using the M60A1 Rise (Reliability Increased Standardized Equipment) Passive model fitted with additional external armor.

The Israeli Army had originally developed the external armor package for the M60 tank as a result of combat experience during the Yom Kippur War. During that conflict lightweight anti-tank missiles destroyed numbers of M60s. In order to add additional protection a kit was developed to add additional armor tiles spaced away from the primary armor. The goal of the kit was to detonate incoming missiles against the tile armor where the jet of hot metal used to pierce armor would be dissipated.

Additionally the Israeli version of the armor used explosive tiles to counteract the blast of the incoming missile. The US Marine version used inactive tiles.

This illustration is of one of the 210 that were used by the Marines during Operation Desert Storm. This was the first and last time the M60 saw combat while in US service.

During Operation Desert Storm flat black inverted V symbols were painted on Coalition vehicles to aid in recognition.



The M60A3 was the final development of the M60 series and featured several improvements including the fitting of a laser rangefinder and the use of thermal imaging sights, which replaced the need for the Xenon searchlight. The Xenon searchlights were removed and the location of the power coupling welded over. (Authors)

D: M60A3 (TANK THERMAL SIGHT)

The final development of the M60 series while in United States service was the M60A3 Tank Thermal Sight (TTS) variant. The M60A3 (TTS) featured an upgraded engine, wiring, higher output alternator, and grenade launchers. Improved gunnery equipment rounded out the upgrade package. Replacing the stereoscopic rangefinder and Xenon spotlight, were a laser rangefinder, thermal sights to allow engagement and spotting of targets in dust and smoke as well as at night, thermal shield for the gun tube and a new ballistic computer.

Over 5,400 M60A1s were upgraded to the A3 standard and served in the US Army through the 1990s. Though no longer in the US inventory, this model continues to serve in armed forces around the world.

E1: GENERAL DYNAMICS 120S

With over 7,000 M60 tanks produced of all variants, many continue to serve around the world with many armed forces. With the cost of a new tank being prohibitive, many have sought to upgrade their existing M60 tanks with the latest technologies. General Dynamics Land Systems, producer of the M60 and M1 tanks, has developed the 120S in response to a Turkish request for proposals to upgrade its M60 fleet.

The 120S mates the turret of the M1 Abrams with its 120mm main gun, shoot-on-the-move capability, increased ballistic protection and electronics with the hull of the M60. A new engine, M1A1 suspension and track increase the mobility of the tank while extending the life expectancy and aiding the logistics of parts supply.

As of this writing the 120S has not been adopted by any country.

E2: M60 PANTHER

As part of research into Unmanned Guided Vehicles (UGV) the Omnitech Corporation has taken a surplus M60 tank and removed the turret and installed hardware and cameras for remote operation from a following vehicle. Fitted with an Israeli mine roller, the Panther was used by US troops to clear mines in Bosnia-Herzegovina.

F: M60A2, III/33RD ARMORED REGIMENT, 3RD ARMORED DIVISION

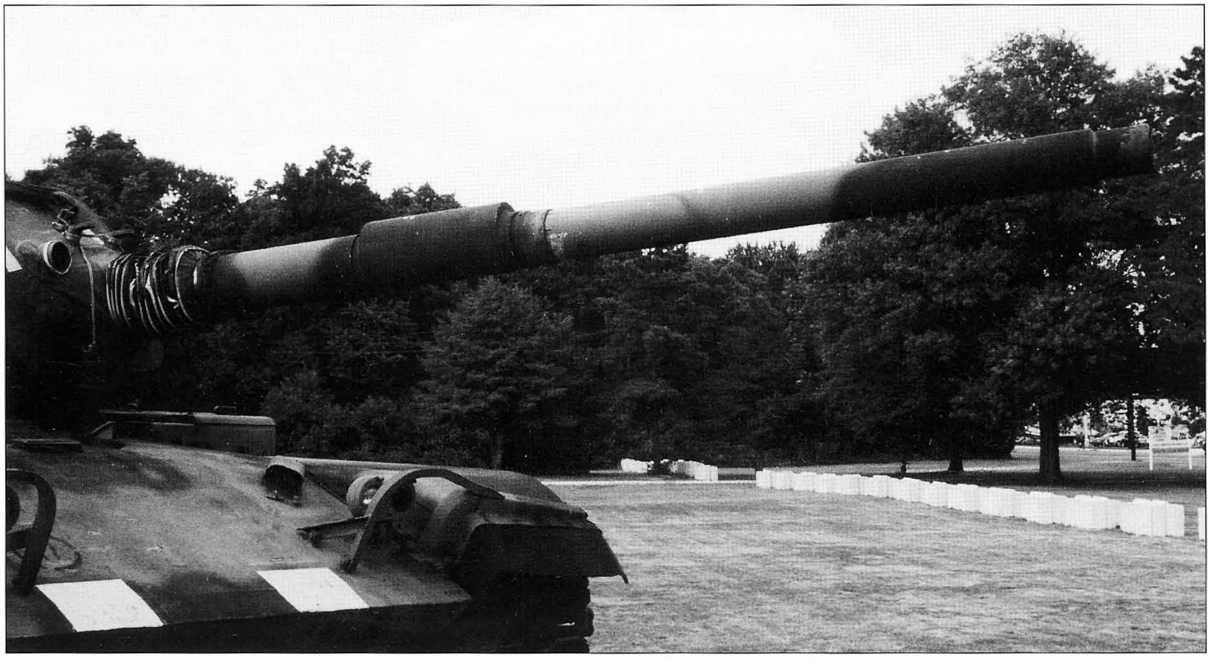
In the 1960s the US Army began to develop a lightweight gun and missile launcher system to replace the main gun on tanks and light armored vehicles. Developed by the Aerospace Division of Ford, the 152mm gun/launcher system called the Shillelagh used a combustible case cartridge for the gun ammunition and a missile.

The Shillelagh system was installed into a newly designed turret for the M60 tank. The turret featured a reduced frontal area with the commander sitting directly behind the gun and the gunner and loader sitting lower on either side of the gun. The M60A2 also used one of the first laser rangefinders. 526 M60A1 tanks were upgraded to the A2 standard; however, the system was overly complex and never popular with tank crews and they were withdrawn from service after only a few years. Many M60A2s had their turrets removed and were converted to armored vehicle bridge launchers (AVLB). This vehicle is marked as belonging to the 3rd Armored Division, 3rd Battalion, and 33rd Armored Regiment.

G1: M728 COMBAT ENGINEER VEHICLE

The M728 is an M60 tank that has been modified with a hydraulically operated blade for removing roadblocks and filling in craters and holes, a boom and winch for lifting duties

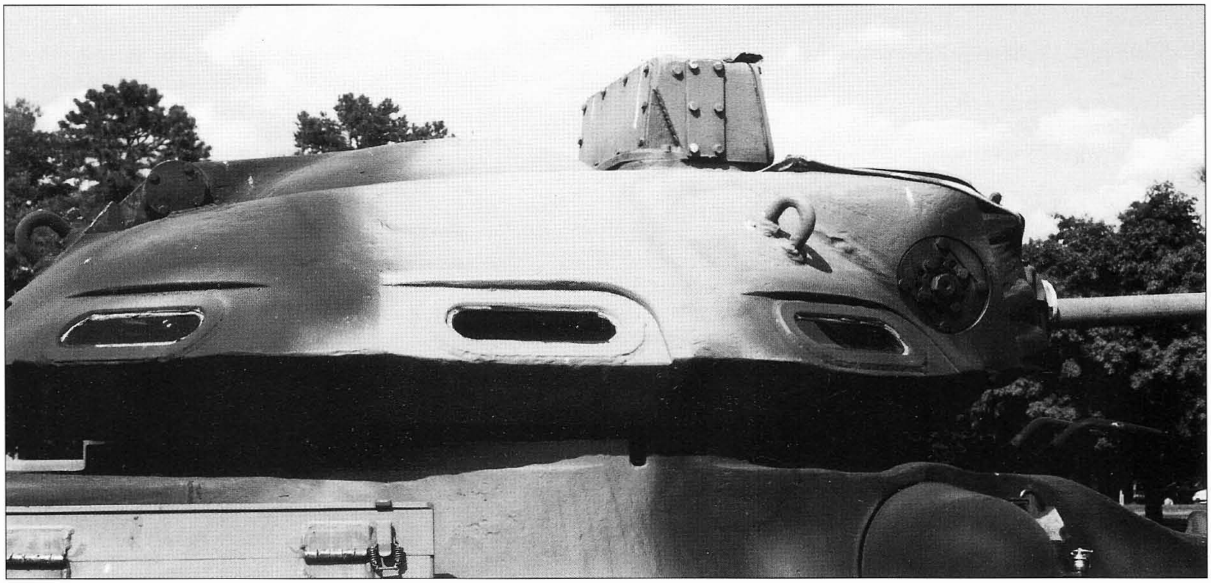
The M60A3 featured a thermal sleeve on the main gun. The thermal sleeve was used to minimize barrel droop. Barrel droop occurred during prolonged firing of the main gun as the gun tube heated up; this affected the accuracy of the main gun. (Authors)



and an M150 165mm demolition gun to demolish bunkers and other strongpoints. Originally fielded in 1961, the M728 continues to serve with US Army Engineer units and will do so for the foreseeable future.

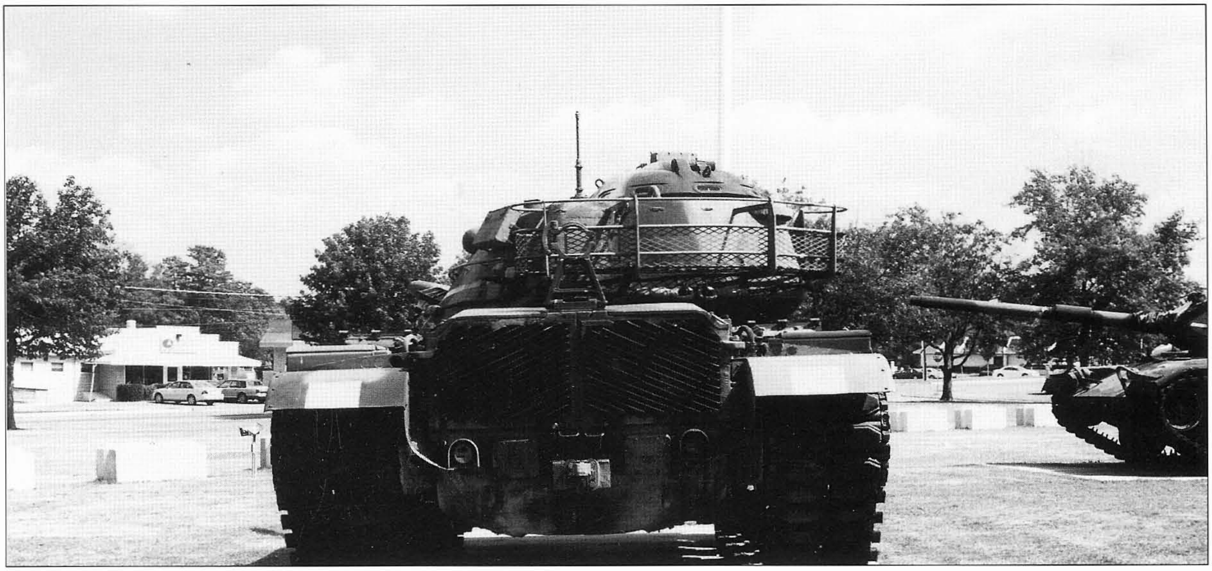
G2: ARMORED VEHICLE LAUNCHED BRIDGE

The Armored Vehicle Launched Bridge is an M60 tank that has had the turret removed and replaced with a folding bridge and emplacement mechanism. The AVLB allows the installation of a bridge capable of crossing an 18m gap while under hostile fire. Originally fielded in the 1960s, the AVLB continues to serve with US Army Engineer units. The average AVLB is 24 years old with 703 launchers currently in use. Current army plans are to upgrade existing units to increase mobility to keep up with the M1 Abrams and M2 Bradley units. With the upgrades the army expects the AVLB to be phased out from 2015 to 2030. Several M60A2s were converted to AVLBs after the army withdrew the M60A2 from active service.



ABOVE **Side view of the commander's cupola. Vision blocks located around the bottom of the cupola allowed the commander 360-degree visibility while operating from within the tank. (Authors)**

BELOW **Rear view of an M60A3 showing the rear doors. The rear doors and top plate of the engine compartment swing open to allow the access to the tank power pack. Fitting of quick attachments for the major lines allows the power pack of the tank to be quickly replaced in the field. (Authors)**



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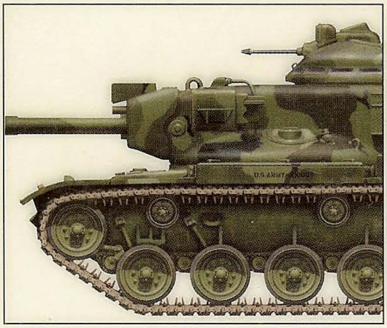

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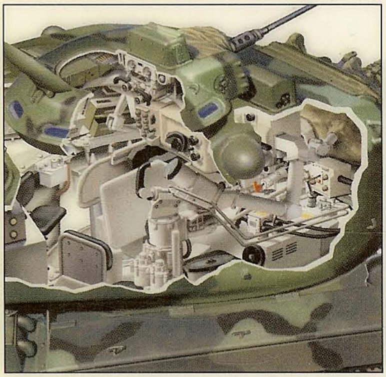

Cutaway artwork

Photographs

M60 Main Battle Tank 1960–91

Entering service in the early 1960s, the M60 tank was in production for 23 years and formed the backbone of US Army and Marine armored units during the Cold War. Over 15,000 were built in four basic models: the M60, M60A1, M60A2, and the M60A3. Although the M60 had been phased out of US Army service by the time Iraq invaded Kuwait in 1990, M60s were amongst the first Allied tanks to enter Kuwait City with the US Marines. This book explores the design and combat history of the very widely-used M60, a vehicle that is still in service today.

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